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The Environmental Impact of Coal Transfer & Terminal Operations

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16. ABSTRACT

This study was conducted to assess current environmental impacts, and to define potential control technology that will minimize the pollution resulting from coal transfer/terminal operations. Environmental impacts from coal transfer/terminal operations can be lessened by employing proper control methods, which should be incorporated into the early stages of planning and design. Coal transfer is an expanding technology, and the construction, operation, and closure/abandonment of new transfer facilities should be monitored and reported. In addition, experiences related to the transfer of western coals should be monitored and reported, since a limited amount of experience has been reported on the handling of these coals.

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THE ENVIRONMENTAL IMPACT OF COAL TRANSFER AND TERMINAL OPERATIONS

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the pollutional impact on our environment and even our health often requires that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

Coal transfer or handling operations are a part of all mining and transportation systems. Special environmental impacts may be related to the transfer or terminal facility which are different or changed slightly from other coal production processes. Information in this report relates to pollutants and control technology applied to such functions as loading and unloading, storage, and transfer of coal. This report should be of interest to state and federal agencies or private companies involved in transportation of coal. For further information contact the Energy Pollution Control Division of IERL-Ci.

David G. Stephan
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Cincinnati

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ABSTRACT

This EPA study was conducted to assess current environmental impacts and to define potential control technology that will minimize the pollution resulting from coal transfer operations and transfer terminal operations. This document is a summary manual that compares and evaluates potential control technologies that may be employed. Major sections are as follows: (1) Discussion of the major differences between western coal and lignites and mid-western or eastern coals; (2) Description of coal transfer operations and transfer terminal facilities; (3) Discussion of potential environmental impacts associated with transfer operations and terminal facilities; and (4) Review and assessment of environmental controls that are employed or available for controlling pollutant sources resulting from coal transfer operations and facilities. An annotated bibliography is provided for selected literature concerning coal transfer.

Environmental impacts can be lessened by employing proper control methods. Specific control methods are applicable to each site and operation, and should be incorporated into the early stages of planning and design.

Coal transfer is an expanding technology, and the construction, operation, and closure/abandonment of new transfer facilities should be monitored and reported.

This report was submitted in fulfillment of Contract No. CI-78-0123 by Delon Hampton and Associates under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from December 1978 to December 1979, and work was completed as of April 1980.

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

BACT	--	best available control technology
Btu	--	British thermal unit
cm	--	centimeter
cu ft	--	cubic feet
dB	--	decibel
ft	--	feet
gal	--	gallons
in	--	inch
km	--	kilometer
lb	--	pound
l	--	liter
m	--	meter
mg	--	milligram
mi	--	mile
ml	--	milliter
mt/y	--	million tons per year
oz	--	ounce
P-E	--	precipitation-evaporation
ppm	--	parts per million
sec	--	second
TSP	--	total suspended particulates
EPA	--	U.S. Environmental Protection Agency
µg/ml	--	micrograms per milliter
ORNL	--	Oak Ridge National Laboratory

SYMBOLS

$CACO_3$	--	Calcium carbonate
Fe	--	iron
Mn	--	manganese
%	--	percent

SECTION 1

INTRODUCTION

Technical data and descriptive information concerning coal transfer and terminal operations are limited. Transfer operations receive little attention in the environmental assessment reports prepared for larger operations such as coal extraction, coal transport, and coal utilization activities, because they are viewed as a small portion of these operations.

In recent years, with more attention being given to increasing coal production, protecting the environment, and reducing the costs of transporting large quantities of coal for long distances, more emphasis is being placed on transfer and terminal operations. Research and development of coal transport operations are increasing. This is evidenced by the development of slurry pipelines, larger and more efficient trucks, trains, barges, and more complex facilities for loading, unloading, and storing coal.

Transfer operations are designed, constructed, and operated so as to accommodate the modes of transportation they serve. In the United States, the methods of transporting coal can be separated into four major categories: railroads, barges, trucks, and miscellaneous (i.e., tramways, conveyors and slurry pipelines).

Railroads carry most of the coal that is transported over long distances. About 50 percent (%) of all U.S. coal produced moves all-rail from mine to market (7). Railroads are involved in moving approximately 70% of all the coal produced in the United States. Barges are the second largest long distances, carriers with approximately 21%. Although coal slurry pipelines are capable of long distance transport, only one pipeline is currently operating, however, currently several are planned or under construction. Trucks and conveyor belts are functional over relatively short distances. Trucks are the major haulers over short distances, although some shipments are as much as 80 kilometers (50 miles), because of their versatility and the widespread availability of public roads. Approximately 11% of all U.S. coal moves all-truck from mine to market. Use of belt conveyors is increasing greatly because of recently developed technology and because they are becoming more cost effective and energy efficient than the trucks they replace. Pneumatic pipelines are currently in common use within power plant facilities to carry coal short distances before entering the firing mechanism. Pneumatic pipelines currently are being considered for other short distance uses.

A relatively new addition to coal handling is the rail-to-barge and/or rail-to-ship transfer (transshipment) facility. Rail-to-barge facilities are

increasing in use particularly for moving western coal to points along the Mississippi River, across the Gulf of Mexico, and to foreign countries (e.g., across the Great Lakes to Canada). A recent spin-off of barge transport is the use of barge-to-barge transfer for conveying coal from one size barge to a different barge or ship for transport over different, but connecting, bodies of water.

Similarly, facilities have been proposed to transport coal from slurry pipelines to wet barges and to ocean-going vessels. Such facilities do not currently exist, however, they have been proposed and the technology appears to be available.

This coal transfer study was authorized and funded by the U.S. Environmental Protection Agency. Its objective was to assess current environmental impacts and to define potential control technology that will minimize the pollution resulting from coal transfer and terminal operations, and to produce a summary manual that compared and evaluated potential control technologies. This manual would be used by government and industry as a source of coal transfer data.

This document consists of the following primary sections: 1) Description of coal transfer operations and of transfer terminal facilities; 2) Discussion of potential environmental impacts associated with transfer operations and transfer terminal facilities; and 3) Review and assessment of environmental controls that are employed or available for controlling pollutant sources resulting from coal transfer operations. The coal transfer activities included in this study are those that occur at all points where coal is transferred from one mode of transport to another, from the point of extraction (i.e., the mine mouth for underground mines, and the point of excavation for surface mines) and the point of utilization (end use). Transfer operations include the loading and unloading of the various transport modes as well as any facilities that are required to assist that transfer (e.g., stacking, reclaiming, and stockpiling and storing). Coal transfer terminal facilities include train-to-barge transfer facilities, coal slurry preparation facilities, and other major facilities used primarily for transferring coal.

Seven site visits were conducted in connection with performing the research for this document. The type of sites visited are:

- Two train--barge and ship facilities, with one having extensive coal storage capability
- Barge--powerplant (under construction)
- Surface mine--overland conveyor - powerplant
- Underground mine--preparation plant - powerplant
- Surface mine--slurry preparation facility
- Slurry pipeline--dewatering facility - powerplant

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The findings of the site visits are reflected throughout the text of this document and more detailed information is contained in Appendix A.

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SECTION 2

CONCLUSION AND RECOMMENDATIONS

Under uncontrolled conditions the construction, operation, and closure of transfer operations and coal transfer terminals would result in adverse environmental impacts. However, these operations and facilities are subject to federal, state, and local rules and regulations, and controls are commonly employed to achieve compliance.

Although not standardized, control methods currently are available for all identified environmental impacts. The applicability and effectiveness of these controls are site and operation specific. In many cases, control methods cannot be compared because of lack of standardization, variation that exists between sites, and the limited quantity of collected data and available literature.

Environmental planning should be incorporated into the early stages of facility and unit operation design. Early planning increases control options and minimizes control cost.

Little information was found in the literature concerning the construction and closure/abandonment of coal transfer facilities, and energy requirements and efficiency of control methods available for coal transfer applications. A study should be conducted to obtain this type of information. Coal handling facilities differ significantly from other types of facilities, and therefore, general construction and site closure/abandonment information should be supplemented by information collected directly from transfer facilities. The environmental impacts and control methods used during the actual construction and closure/abandonment of the various types of transfer facilities should be collected and reported.

Coal transfer is an evolving and expanding technology. A clear example is the proposal to transport coal by slurry pipeline part of the intended route, and then transferring the wet coal to barges or ships for the remainder of the route. This type of transport would require the application of two new transfer facilities: a) one which transfers the coal slurry to wet barges or ships; and b) another which unloads the barge or ship and transfers to another transport mode, or prepares the coal for utilization. The construction, operation, and closure/abandonment of new types of transfer facilities should be monitored, assessed, and reported.

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Generally, there are significant differences between eastern, midwestern, and western coal. As western coal is targeted for extensive development, and since a limited amount of background has been gained and reported on the handling of western coals, experiences related to the transfer of western coals should be monitored and reported.

SECTION 3

MAJOR DIFFERENCES BETWEEN WESTERN COAL AND LIGNITES, AND MID-WESTERN OR EASTERN COALS

The increased demand for coal, specifically, the demand for low sulfur coal, has targeted western coal and lignite for extensive development. These resources are located in the Northern Great Plains and Rocky Mountain coal provinces. Because of their somewhat remote locations, western coal and lignite was not, until recent years, a high priority area for coal development. Eastern coals, although not close to the surface and often containing higher amounts of sulfur, were developed first and used extensively because of the relatively short transport distance to consumers. However, the Clean Air Act has made it more difficult to burn high sulphur-content coals, and will lead to increased quantities of western coal being shipped east.

Experience over the past several years has shown that there are basic differences between western coals and lignites, and mid-western and eastern coals. According to Johnson (26), western coals have been shown by sample analysis to have lower calorific values, higher moisture content, lower hardgrove grindability index numbers, different particle shapes, and a higher friability (i.e., fractures more easily). Johnson also reported the following differences found in western coals and lignites as compared to mid-western or eastern coals based on experience:

1. Wider range of flowability characteristics;
2. Higher percentage of impurities;
3. Higher percentage of fines;
4. Higher susceptibility to spontaneous combustion;
5. Dustier, even though the moisture content is higher;
6. Stickier when subjected to additional moisture;
7. More abrasive;
8. More degradation during handling.

As discussed below, many of these differences affect the polluting potential of the coal or lignite.

The most significant difference between western coals and lignites, and mid-western and eastern coals is calorific values. Using common calorific values of 12,000 Btu/lb for mid-western and eastern coals, 8,600 Btu/lb for western coal and 7,000 Btu/lb for lignite, it would require approximately 60% more western coal and 29% more lignite to obtain the equivalent heating value of mid-western and eastern coals. These figures indicate that larger quantities of western coals and lignite must be transferred, handled, stockpiled, and stored to equal the energy equivalent of mid-western and eastern coals.

Accommodation of these larger quantities of coal requires larger coal handling equipment, and thus additional land space. For example, as calculated by Johnson (26), the land areas required for reserve or emergency stockpiles to sustain a 550 megawatt gross rated unit at full load for 90 days would be 24% larger for western coals, and 54% larger for lignites than for equivalent piles of mid-western or eastern coals. These figures do not include land requirements for drainage ditches and settling basins for runoff.

Western coals and lignites are much more susceptible to spontaneous combustion due to the tendency of these lower ranked coals and lignites to oxidize when exposed to the atmosphere. Friable coals, which crumble very easily, usually contain a higher percentage of fines and aggravate the oxidation process because they provide more surface area through breakage. Western coal, being more friable, will undergo more oxidation and coal degradation during compaction. Because initial densities of western coals and lignites are lower than those of mid-western and eastern coals, more compaction is required. Johnson's (26) recommended compaction for western coals and lignites to prevent spontaneous combustion is 65 to 70 lbs/ft^3. Increased compaction requires more use of compacting equipment, and subsequently, more fugitive dust. The increased potential for spontaneous combustion in western coals and lignites has led to the consideration of installing fire detection and protection systems which require a substantial capital investment.

Another significant difference between western coals and mid-western or eastern coals is their sulfur content and thus the potential for generating acid mine drainage. In general, western coals have a lower sulfur content, although coals with high sulfur content have been identified. Though generally high in sulfur, eastern and mid-western coals containing low quantities of sulfur are being mined. In view of these facts, specific conditions should be taken into consideration. Generally, the mining of low-sulfur western coal does not result in acid formation because of the low concentrations of iron sulfide, the relatively dry climatological conditions, and the buffering capacity of the soil which tends to be neutral to alkaline.

SECTION 4

DESCRIPTION OF TRANSFER OPERATIONS AND TERMINAL FACILITIES

The following is a description of transfer operations and transfer terminal facilities. Transfer facilities are custom-designed according to site-specific requirements and conditions. These conditions include, but are not limited to, the following: the quantity and quality of coal handled, the incoming and outgoing modes of coal transportation, the physical size and shape of the site, the function and orientation of the site as a whole, meteorological conditions of the site area, and economics. Given specific site conditions, often there are several options of transfer methods and equipment that could be used. Block diagrams in simplified form for each major category of operations are shown in Appendix A.

TRANSFER OPERATIONS AT MINE SITE

Coal mines do not store large amounts of coal because of safety hazards, Bureau of Mines regulations, and the mechanization of today's mines (9). Stockpiles are temporary storage piles where coal is kept for anticipated emergencies, or before being transferred to other locations.

There are normally two major transfer points at an underground coal mine site: (1) transfer from the device that brings coal out of the mine to the mine site stockpile, and (2) transfer from the mine site stockpile to the transport device that carries the coal from the mine site. Transfer facilities associated with transfer operations usually include a type of stockpile (e.g., open stockpile, silo, hoppers) and a loading system (e.g., loading tunnel).

Surface mining of coal usually involves three transfer operations: (1) transfer from the mining device to the onsite transport device; (2) transfer from the onsite transport device to the mine site stockpile; and (3) transfer from the mine site stockpile to the transport mode that carries the coal from the mine.

In the past, trucks have been used almost exclusively for onsite transport of the surface mined coal, however, the use of conveyor belts is increasing. As annual tonnages and haulage distances increase, and advances are made in conveyor technology, the costs of installing and operating conveyor belts become more favorable.

TRAIN LOADING AND UNLOADING

The most efficient method of rail transportation for large mines is by unit trains. A unit train carries a single commodity in dedicated service between two points with the possibility of alternating trips to other destinations to better utilize equipment. Mines not large enough to support the use of unit trains usually use bulk rate trains. Loading and unloading of rail cars pulled by bulk rate trains are less mechanized.

Storage for unit train flood-loading is either in open piles on the ground, or in silos or bins. Ground storage is currently the most common method of accumulating the supply necessary for high-speed unit train loading; however, the use of large enclosed silos has increased recently.

The most popular form of open-space storage is the single conical pile. To facilitate train loading, the pile may be situated directly over a loading station to minimize handling of the coal. A loading station commonly consists of a surge bin, located above the track and large enough to hold incoming coal while cars are changing, a loadout chute, and a control room. The chute is a large, vertical telescopic device that travels to the car bottom with each new car, rises with the coal as the car is filled, stops and crowns the car, then stops the flow of coal as the cars are changed and repeats the cycle. During loadings, the chute remains in contact with the coal in the car and thus prevents the escape of dust and the spillage of coal.

An alternative to using a loading station is to position the storage pile on the ground and reclaim it by using a device for removing coal from the surface of the pile, or by using a reclaiming system positioned at the bottom of the pile. Both methods usually place the coal on a conveyor belt that feeds the coal directly to the rail cars or to bins located above the track.

Front-end loaders are a versatile means of loading rail cars. However, they do not possess the speed and efficiency required for loading unit trains. Front-end loaders are still used sometimes at small mines where high equipment expenses are not practical and speed is not critical.

The unit train concept has led to the use of rotating car dumpers with swivel couplings that unload each car by causing it to turn and empty its coal content into hoppers without uncoupling the rail cars. The hopper allocates the coal onto a conveyor belt which moves it toward a stockpile or storage area. An older and commonly used system for unit train unloading employs rail cars with bottom discharge hatches which discharge coal either to open stockpiles or hoppers located below the track. Some form of shaker or vibrator is often required for complete discharge of the contents from the rail car, especially for wet coal.

The coal in rail cars can freeze requiring a thawing shed to melt the bond between the rail car and the frozen coal. Two modern systems for thawing are the gas infrared and the electric infrared. A coal shaker may also be needed when hopper cars are involved. Instead of thaw sheds, mechanical devices are sometimes used to break ice bonds.

CONVEYOR LOADING AND UNLOADING

Conveyors are used extensively to move coal at underground mines, in coal stockpile and storage areas, and for loading and unloading. Conveyors are also commonly used to move coal short distances, generally up to about 15 kilometers (km) (10 mi). Two examples of short distance use of conveyors is for coal movement from mines to nearby barge/ship loading facilities, and from mines directly to nearby electric power generating plants. Coal is reduced to a predetermined size by crushers before it is placed on a conveyor.

Conveyors have been proven technically feasible and are being considered for long distance overland coal transport, and for uses requiring mobile conveyors. Overland conveyors of lengths greater than 322 km (200 mi) have been proposed and would be used instead of trucks, trains, or slurry pipeline. Many conveyors are covered. Mobile conveyors can now be designed to follow mining equipment at surface mine sites and replace onsite haulage by truck. These mobile conveyors can also be used to modify coal handling at storage piles.

How a conveyor is loaded depends on how it interfaces with the device handling the coal prior to its placement on the conveyor. Some of the common ways to load a conveyor are as follows:

1. Placement on the belt by a reclaimer which systematically deposits small amounts of coal on the belt.

2. Feed from a bin or hopper having some method of controlling flow.

3. Controlled flow from one conveyor belt to another.

For unloading the coal from a conveyor, the coal is usually allowed to simply fall from the terminal end of the conveyor. Devices such as telescopic chutes may be placed at the end of the conveyor to protect the coal from the influence of the environment, thus reducing fugitive emissions.

Conveyor belt wear is significantly more at transfer points due to impact and acceleration forces. Thus, minimizing the transfer points is desirable for both economical and environmental reasons. The primary impacts of conveyor belt operation are spillage and fugitive dust emissions at feeding, transfer, and discharge points.

TRUCK LOADING AND UNLOADING

The most common use of trucks is to transport coal at surface mining sites from the point of excavation to either the mine site stockpile or storage area, or when economical, directly to the end user's stockpile or storage area. At surface mines the coal is loaded on the truck either by the shovel performing the digging or by a front-end loader. In most other situations where trucks are used, loading is commonly accomplished by feed from an overhead bin, use of a front-end loader, or by feed from a conveyor.

Two types of trucks are commonly used: those that tilt to unload, and bottom dumping trucks. Trucks of the type that tilt to unload are usually smaller in size, and discharge the coal directly onto stockpiles or storage areas or in bins or hoppers. Bottom dumping trucks usually drop their contents into hoppers located below an opening in the roadway.

Truck loading and unloading operations are potential sources of fugitive dust. A common method of unloading coal is to dump the coal into bins which have feeders underneath to transfer the coal to a conveyor. Dust can escape during transfer from truck to bin, and from bin to conveyor. Dust emissions may be substantial if the coal is dry and fine, and the wind speed is high.

BARGE LOADING FACILITIES

In the 1974 Keystone Coal Industry Manual, barge loading is categorized into five classes:

1. A simple dock from which trucks dump into the barge when water conditions permit.

2. The stationary-chute type which works well where the river does not fluctuate greatly and banks are steep.

3. Elevating-boom type, with barges moved back and forth in the river beneath. This type is advantageous where the bank of the river is a considerable distance from the channel, and the elevating boom and conveyor belt can be combined for travel across the floodplain.

4. Floating-type, with the loading boom mounted on a floating or spar barge and pivoted for easier loading. This method requires a steep bank or fill to permit retraction and extension of the main conveyor with changes in water level.

5. The tripper-conveyor type, in which the barges are stationary and the loading chute moves back and forth to load and trim. The current trend appears to be toward the tripper-conveyor type for barges and mobile loaders for ships.

Coal can be delivered to the barge loading site by any mode of transport. The type of unloading system, and to some extent, the stockpiling configuration, depends upon the way the coal arrives at the site. All existing barge and ship loading facilities handle dry coal delivered by either train, conveyor, or truck. Unloading of these modes of transport are discussed in other sections of this report. A barge loading facility has been proposed that would handle coal received by pipeline. The coal would be loaded wet, with excess water being removed from the vessel, and treated and disposed of based on accepted engineering practices (24).

BARGE UNLOADING

A typical barge unloading station includes a system of unloading the barge, a receiving bin with feeders and a conveyor or facility for loading the transport method used for moving the coal to the user's stockpile or storage area. Barge unloading, until recently, was most commonly accomplished using clamshell buckets. Continuous bucket unloading systems have been developed and are being used in the newer facilities.

Environmental concerns associated with barge unloading include fugitive dust contamination of the water due to runoff and dust fallout, and aesthetic impacts.

TRANSFER OPERATIONS AT COAL SLURRY FACILITY

Only one commercial coal slurry pipeline is currently operating in the United States. It is the Black Mesa pipeline, which has been operating successfully since 1970. Black Mesa Pipeline Company operates the 46 centimeter (cm) (18 in) diameter pipeline, which transports 4.5 million metric tons (5 million tons) of coal per year over a distance of 437 km (273 mi) from the Black Mesa coal field in Arizona to the Mohave generating station in Nevada. The first and only other major long distance coal slurry pipeline was put into operation in 1957. It was 174 km (108 mi) long from Cadiz to Cleveland and owned by the Consolidation Coal Company. Operation of the Cadiz-Cleveland pipeline was discontinued and the system mothballed due to the onset of unit trains. Seven new coal slurry pipelines are currently planned or proposed (Table 1). Transferring coal from stockpiles to the slurry preparation plant requires only one transfer point, that is, from the transport device bringing coal from the stockpile to the receiving bin or hopper at the preparation plant. Slurry exits the preparation plant and is sent to a pumping station.

At the slurry preparation facility for the Black Mesa pipeline, coal is delivered from a surface mine via bottom-dumping trucks which unload the coal to hoppers located below an elevated roadway. A cloud of fugitive dust can usually be observed during the truck dumping. Coal is then moved by conveyor through a crusher to a stacker that forms a stockpile. Coal can also be moved to an area for long-term storage. From a transfer tower located at the mine site, coal (size 5.1 cm x 0) is conveyed to one of three cylindrical bunkers located above the preparation plant. Each bin feeds a process line consisting of an impact crusher, a rod mill, a sump, and a centrifugal pump. Impactors reduce the coal to -0.60 cm x 0 by dry crushing, then feeds it to rod mills where it's screened through .32 cm screens. The oversized material is recirculated through the mill. Slurry is formed in the rod mills where water is introduced from the rod mill sump. It is then pumped into one of four 2.4 million liter (630,000 gallons) storage tanks which are open topped and equipped with mechanical agitators to maintain slurry suspension. Slurry is transferred from storage tanks by centrifugal charge pumps into the suction of mainline high pressure pumps. The pipeline system includes the slurry preparation plant, four pump stations (the first station located at the slurry preparation facility), pipeline test loops, and control and communication facilities (31). Once the coal is inside the preparation plant, no pollutant streams are produced.

TABLE 1. PLANNED U.S. COAL SLURRY PIPELINES

Pipeline System	Route	Length (km)	Capacity (mt/y)
Energy Transportation Systems Inc.	Wyoming to Arkansas and Louisiana	2,205	22
Nevada Power	Utah to Nevada	288	11
Northwest (Snake River)	Wyoming to Oregon	1,760	9
San Marco (Houston Natural Gas)	Colorado to Texas	1,440	14
Texas Eastern	Wyoming to Texas	1,920	22
Florida Gas	Kentucky to Florida	2,400	22-45
Boeing	Utah to California	1,040	9

Source: Thompson, T.L. and W.H. Hale. Slurry Pipelines - What, Where, When. In: Proceedings of the 2nd International Coal Utilization Conference and Exhibition, Houston, Texas, 1979. pp. 147-160.

At each of the three pump stations along the pipeline route a dump pond is provided with capacity to hold upstream line fill in case of emergency. A water pond is also provided at each station for use in flushing the downstream section if emergency should require.

The coal transported by the Black Mesa pipeline is not cleaned to reduce ash or sulfur content. Water for the system is supplied by seven deep wells and an emergency reservoir. The wells are 1067 meter (m) (3500 ft.) to 1128 m (3700 ft.) deep, and casings are used to protect the shallow-well groundwater supplies (31).

Corrosion inhibitors may be added to the slurry to minimize corrosion. Consolidated Coal Company patented a process that involves the addition of 12 parts per million (ppm) each of a chromate and polyphosphate, together with a pH above 6, to control corrosion (3). The patent claims that the chromate is removed from the water by fine coal present in the clarifiers. Others claim the use of 10 to 1000 ppm of chromate coupled with organic phenols, polyacrylamides, or alkylene oxides for corrosion control. Polyalkylbenzenes, and many other compounds, may also be used to adjust the viscosity of the coal slurries (35).

With the exception of the transfer point for coal entering the coal preparation facility, there are no air emissions directly attributed to the transfer of coal by slurry pipeline under normal operating conditions. Equipment at the preparation facility and pump stations is electrically powered. Noise is not commonly a problem due to the remote locations of these facilities. Also most facilities are enclosed and equipped with noise shields.

TRANSFER OPERATIONS AT TERMINAL END OF SLURRY PIPELINE

The Black Mesa pipeline terminates at the Mohave Generating Station, located near Laughlin, Nevada. Three basic coal slurry systems are maintained at the station. These systems are: the slurry storage and transfer system, the slurry feed system, and the reslurry systems.

Arriving slurry is normally directed to one of four coal slurry "active" storage tanks to assure a smooth, uninterrupted flow of fuel. Each tank is 26.5 m (87 ft.) in height and is rated at a total storage volume of 30.3 million liters (8 million gal). Agitators are used for continuous mixing of the material. Piping arrangements are also provided to divert flow from the pipeline to any one of seven onsite storage ponds. Slurry can also be transferred from one active storage tank to any of the inactive storage ponds.

Slurry is pumped from the active storage tanks, through a slurry heat exchanger to reduce its viscosity, and to the fuel processing equipment. A return line to the active storage tanks maintains continuous flow in the supply lines. Coal is separated from water by centrifuges which then send the coal (20-30% water) to pulverizers. From the pulverizers, the coal is moved to the furnaces pneumatically. Water from the centrifuges (centrate) containing 5-6% solids is directed to thickener tanks (clariflocculators), where additional solids are separated from the water. Before entering the thickeners, the centrate is treated with polymer flocculants. The underflow containing 20-26%

coal solids is pumped to the boilers, diffused into the furnace fireball, and burned as fuel. Overflow from the clariflocculator tanks containing approximately 20 ppm suspended solids is directed to the plant's cooling water system for use as cooling-tower makeup. This overflow represents about 10% of the plant's requirement. All cooling-tower blowdown is pumped to evaporation ponds since no water can be returned to the Colorado River or allowed to drain into the groundwater.

By original design, coal in the Mohave slurry handling system, which has been diverted to inactive storage, is allowed to settle, and the water is decanted for use in the cooling water systems. After a drying period of two to three months, the coal is excavated and relocated to a storage bunker. When needed, the coal is loaded into trucks and transported to two underground hoppers. The coal is then fed onto a conveyor belt which carries it to a mixing chamber where water is introduced. The mixture is screened of rocks and other debris and directed to mixing tanks where the consistency and density of the material is adjusted. The resulting slurry is pumped to active storage tanks.

Several factors including pipeline capacity, labor cost, and environmental factors led to the conlcusion that a new storage and reslurrying system was needed at Mohave. The operating principle of the new system is as follows: A slowly oscillating high-energy jet stream of water is directed from a central location into a bed of material to undercut that material. The material collapses into the stream of water, is reslurried, then flows back to a slurry pump located near the jet. During the flowback, the slurry does not encounter the jet stream and must maintain sufficient velocity to keep the particles in suspension. This forms a natural slope leading back to the pump, generally in the shape of a crescent. This new system was designed into four disk-shaped ponds, 133 m (436 ft) in diameter and 12.2 m (40 ft) deep at their centers. The four ponds are arranged in a four-leaf clover configuration. Two sets of four ponds are to be used, having a total 40-day coal supply (13).

It was demonstrated that being able to store the coal as a slurry and maintaining a level of water on the surface have eliminated the problems of fugitive coal dust emissions and the occurrence of spontaneous combustion in the stored coal (13).

TRANSFER OPERATIONS AT COAL PREPARATION SITES

Most coals undergo some type of preparation before delivery to the consumer. The extent of preparation is determined by the quality of the coal, the mode and economics of transport from the mine to the consumer, and the requirements of the consumer. Usually, approximately 50% of all the bituminous coal and lignite produced in the United States is mechanically cleaned at a coal preparation facility. Mechanical sizing alone does not normally require a separate facility. Some of the reasons for coal preparation are:

1. Reduction of pyritic sulfur from coal;

2. Concentration of carbon in the clean coal;

3. Reduction of ash content of the coal;

4. Reduction in concentration of trace elements;

5. Adjustment for uniform quality of product including ash, moisture, and Btu content.

There are five transfer points normally associated with a coal preparation plant: (1) Transfer from incoming transport mode to surge bins; (2) Transfer from the surge bins to plant stockpile or storage area (usually screening and crushing of the coal also involved); (3) Transfer from the stockpile to the preparation plant; (4) Transfer from the preparation plant to clean coal stockpile and storage area; (5) Transfer from clean coal storage to outgoing transport mode. The transfer equipment/facilities normally involved are the surge bins, plant stockpile and storage area, and clean coal stockpile and storage area.

When the run of mine (ROM) coal is delivered to the preparation plant site, it is dumped into a surge bin or surge feeder which controls the feed through the first process module. The plant location in relationship to one or more mines, and the mode of transport of the ROM coal to the preparation plant site, play an important role not only in determining whether or not the stockpiling and/or storage function occurs before or after the initial size check and size reduction, but also in determining the method of stockpiling and storage. For example, if the preparation plant is a long distance from the mine, and the primary method of hauling the ROM coal is by rail cars, the ROM coal will usually be held in the rail cars and processed through the initial size check and size reduction only as needed for feedstock. If, on the other hand, the coal is transported to the plant site by conveyor or truck, major delays may occur in the mining operation if some storage is not provided at the plant site.

COAL STOCKPILES AND STORAGE PILES

As used here, stockpiles and quantities of coal that are involved in the normal operations of the site are sometimes referred to as active storage or short-term storage. Storage refers to quantities of coal held in reserve for times when the quantity of coal available in stockpiles is unable to meet demand. Storage piles are usually much larger than stockpiles, and the turnover time of coal held in storage may be significantly greater. The greater size and average age of the coal generally makes storage more of a potential environmental hazard.

Coal held in storage is usually piled on the ground in an area near to but separate from the stockpile. The amount of coal held in storage is normally 30 to 120 times the daily capacity of the operation demand in which it is involved. The design and construction of the storage pile depends on the method used to move coal to storage, and the reclaiming method. Fugitive dust, surface run-off, and leachate are also major environmental issues that should be considered in the design.

Open storage is rapidly becoming a thing of the past, but it is still a viable method if proper consideration is given to fugitive dust and runoff control. The location of the facility and local environmental requirements may rule out open storage, but it should be included in initial considerations. Even with the expense of acceptable dust and runoff controls, open storage can be considerably less expensive than covered storage (8).

Stockpiles may be open or closed to the atmosphere. Stockpiles may also be positioned on the ground or elevated. As with storage piles, the design and construction of the stockpile depends on factors such as the method of stacking, the method of reclamation, and environment.

Open stockpiles positioned on the ground are usually conical or wedge-shaped. The conical piles are the simplest form of storage. Reclaiming is often accomplished by a reclaim conveyor located beneath the pile. Mobil equipment is used, when needed, to push coal in dead storage areas to a location where the coal is accessible to the reclaim conveyor. Several methods have been developed to reduce the dead storage area while simultaneously reducing environmental impacts. Two such methods are: 1) Surrounding the stockpile with a dike; 2) Constructing a structure with sloped sides, that is recessed so the surface of the pile will be nearly flush with ground level.

Wedge-shaped piles are built with a travelling stacker operated with a belt conveyor running parallel to the pile. The conveyor is generally elevated to about half the height of the pile, either on an earth fill or on a steel structure. The pile is built as the movable tripper slowly traverses the length of the pile. The stacker may have either a fixed or a hinged boom, the latter serving to practically eliminate dust problems.

Wedge-shaped piles can be reclaimed by using an under-the-pile conveyor system similar to that used for conical piles, or a stacker/reclaimer system may be employed for both functions. The stacker/reclaimer system is a more recent innovation, adopted from strip mining technology and initially used at power plants, but is now used at preparation plants and other facilities. It is a versatile storage method which allows storage on both sides of the conveyor track. However, using the stacker/reclaimer to remove coal from a pile will probably generate more dust than reclaiming systems located beneath the pile.

Another type of open storage, frequently found at power plants and finding increased application in preparation plants, is the kidney-shaped stockpile. The kidney-shaped stockpile is formed by a stationary radial stacker with a boom that rotates through an arc, and which raises and lowers as necessary. The stacker may be either ground or tower mounted.

Storing coal in enclosed structures is considered best available control technology (BACT) in many parts of the country and may be required at all locations in the future. Enclosed storage provides protection against the elements, minimizes the potential for airborne pollutants, provides for nearly 100% live storage, and permits the transfer to rail cars without complex mechanical devices. Various types of enclosed bins and silos are available. The majority of the large capacity enclosures are cylindrical in shape and made of steel or concrete. The current trend is toward elevated enclosures that

permit rail cars to pass beneath and be loaded through a feeder. Another method of removing coal from the enclosure is to use a reclaim conveyor located beneath an elevated enclosure, or in a reclaim tunnel located in an enclosed position on the ground.

According to Chrystal (8), there were over 150 large diameter coal silos in use in the United States in 1979. Storing coal in a 100% live storage facility, such as silos, eliminates the expense and environmental impact of using mobile equipment and the associated maintenance required for reclaiming dead storage. Silos also reduce the possibility of hot spots developing on the coal pile. Other advantages of silos and other closed storage systems are the elimination of the need for runoff control systems, and the reduction of dust control requirements.

PNEUMATIC PIPELINES

A pneumatic pipeline represents relatively new technology for transporting coal. Presently, they are used for transporting coal over relatively short distances. Basically, it is a pressurized pipeline into which coal is fed and conveyed in a suspended state by compressed air. Currently, the most feasible application of pneumatic pipelines appears to be movement of coal to and from a rail terminal. Pneumatic pipelines could be particularly advantageous in the West because they require no water. An above ground pneumatic system requires minimal ground preparation and can be designed to be portable.

The system consists of a compressor to supply air pressure, silos for storing the coal to be fed into the pipeline, and a cyclone and baghouse to remove it at the end. At the terminal end, a cyclone could remove particles larger than 5 microns in diameter at efficiencies of about 98%. The remaining particles may be removed in a baghouse or other air quality control system.

MISCELLANEOUS

A crushing device or facility is often included in transfer and handling operations. Crushers may be located at the mine, the preparation plant, transfer terminals, or at the power plant. Crusher installations are extremely dusty and noisy, and when not enclosed would lose 1 or 2% of the coal in the form of fugitive dust, depending upon wind velocity and the coal being crushed.

SECTION 5

ENVIRONMENTAL IMPACT OF TRANSFER OPERATIONS

INTRODUCTION

Summarized here are various environmental impacts associated with coal transfer operations and transfer terminal facilities. These operations and facilities include: loading, unloading, stockpiling and storing, reclaiming, and all operations associated with facilities used primarily for coal transfer. In addition, the environmental impacts associated with the construction of new facilities and abandonment of existing facilities will be considered.

The environmental impacts discussed are:

- Water quality
- Water use
- Site abandonment
- Air quality
- Noise
- Aesthetics
- Land use

WATER QUALITY

Loading, Unloading, Stacking, and Reclaiming

Loading, unloading, stacking, and reclaiming coal may contribute to changes in water quality due to the interaction of water with dust fallout and coal spillage generated by these operations. The quantities of fugitive dust and spillage generated will depend upon the type of operation and the efficiency of environmental controls, if employed. Fugitive dust and spilled coal will settle on the site or be carried off-site and settle on nearby land and water resources. Water contacting this coal may be degraded in quality, taking on suspended and dissolved solids. The amount of water quality degradation would therefore be a function of the quantity and quality of fugitive dust and spillage generated, and the characteristics of contacted water.

Coal Stockpiles and Storage

Coal stockpiles and storage areas which are exposed to the environment are a major potential source of water pollution at coal handling facilities. Coal storage piles produce effluents resulting from the drainage and runoff of water which occur during and after precipitation. Precipitation drains and leaches soluble pollutants from the coal which may affect aquatic life in nearby waterways.

Coal contains many elements and compounds, often in trace amounts. The effect of coal on contacted water and nearby receiving water depends on factors including:

- Volume of coal stored
- Coal particle size
- Surface area of the coal pile
- Coal pile geometry, configuration (i.e., angle of side slopes)
- Compaction of coal pile
- Characteristics of soil layers beneath coal storage pile (e.g., permeability)
- Amount of precipitation
- Intensity of rainfall
- Climate
- Nature of terrain and hydrology of area surrounding the coal pile
- Quality of surface and groundwater contacting the coal

Efforts have been made to quantify the amount of runoff from coal storage piles. Cox, et al. (14), found from results of a rainfall-regression analysis that about 73% of the total rainfall can be accounted for as direct runoff; percolation into the coal pile and evaporation was assumed to make up the remaining 27%. Another estimation of the runoff from a coal storage area, in conflict with that reported by Cox, et al., was used by the Army Corps of Engineers (37); they assumed 25% runoff.

The major parameters of concern in the runoff from eastern high sulfur coals are low pH, trace and heavy metal content, and suspended solids and fines, which include solid mineral debris, sediment, and dissolved and colloidal material (39). Factors that affect production of acidity in coal piles and the subsequent leaching of trace metals are (5, 6, 14, 16, 28, 29):

- Concentration and form of pyrite sulfur in coal
- Method of coal preparation and cleaning before storage
- Climate, including rainfall and temperature
- Concentration of $CaCO_3$ and other neutralizing substances in the coal
- Concentration and form of trace metals in the coal
- Residence time of water in the coal pile
- Coal particle size which determines amount of exposed surface area
- Coal rank, type, and age

The pyritic sulfur content of the coal is a major factor because it is the primary acid forming substance. Metals are more likely to solubilize in low pH runoff/leachate.

Coal particle size has been shown to be important as it directly determines the surface area of the coal sample being studied. Samples with larger exposed surface areas are more heavily oxidized and retain more rainfall, thus yielding a leachate with higher metal concentration than coal samples with less available surface area (5, 40).

Coal rank also provides an important indicator of the pollution potential of coal pile storage. Lower rank coals (lignite and sub-bituminous) tends to oxidize and slack (weather or disintegrate) faster than higher rank coals (anthracite). If all other factors were equal, the lower rank coals would yield pollutants more quickly than higher rank coals since the pollutants are largely oxidation products (16, 28, 40). However, lower rank coals contain much less pyritic sulfur than higher rank coals, thus, the acid-forming potential of low rank coals is significantly less than that of higher rank coals.

The Oak Ridge National Laboratory (ORNL) has studied different types of coal (eastern and western) and their effect on leachate/runoff characteristics (5, 6). ORNL reported the results of a 14-week rainfall simulation laboratory experiment on the relationship between type of coal and resulting pH of the leachate, using eastern coal with 4.78% sulfur content and a western coal with a 0.37% sulfur content. The results clearly indicate that the eastern, high sulfur coal has a much lower leachate pH than the western, low sulfur coal. This increased the pollution potential of the eastern coal and its ability to leach heavy metals significantly. The data also showed that the sulfate content of the eastern coal is much higher than that of the western coal, and adds evidence to support the direct proportional relationship between sulfur content of the coal and potential acid-formation within the coal pile.

Other factors governing the quality of coal pile drainage is frequency of rainfall and age of the coal. Wachter and Blackwood (40) conducted a rainfall experiment to collect data on these factors. The data they presented showed

that the aged coal produced a lower pH and higher sulfate concentration as compared to the fresh coal. The different effluents in relation to frequency of rainfall for both fresh and aged coals may be attributable to the length of time the coal pile has had to form pyritic oxidation products and acid leachate, and in turn, increase of dissolved heavy metal concentrations. It would seem that the longer the interval between rainfall events, the more oxidation of the coal that is likely to occur, thus increasing the pollution potential of the coal pile.

Anderson (1) reported that during periods of no precipitation, retained moisture within the coal pile is dissolving minerals that are then flushed from the pile during precipitation. If there is sufficient precipitation, almost all of the dissolved minerals are flushed from the pile, and after the first flush, only minor concentrations of minerals are carried from the pile in continuing coal pile leachate flows. Reportedly, this is particularly true of total iron, copper, manganese, chromium, and zinc. Anderson's statement does not consider oxidation or aging, and the influence of adding fresh coal to the coal pile.

The discharge of untreated leachate and contaminated runoff from coal piles into surface or groundwater may cause several environmental impacts. Potential adverse impacts include:

1. The alteration of the pH of receiving streams.

2. The precipitation of metallic hydroxides in larger or higher buffered receiving streams, which can result in flocculant coatings that cover the stream bottom and destroy benthic organisms.

3. Significantly increase the concentrations of trace metals in receiving waters. Metals can be biomagnified in the food chain and may affect humans as well as other animals.

4. Percolation through soils and contamination of groundwater with heavy metals and depressed pH.

5. Increase turbidity.

6. Reduce oxygen content of the water through chemical oxygen demand.

Increased turbidity, caused by the presence of coal fines in a body of water, reduces the depth of effective photosynthesis by rapidly absorbing radiant energy in upper water layers. This may inhibit the algal growth potential which increased nutrients might promote. Increased turbidity also delays the self-purification of water and can allow the distant transport of organic waste. In high concentrations, usually greater than 40,000 mg/1 (5 oz/gal), turbidity has been found to cause severe injury or death to many fish species (30).

The discharge of untreated leachate/runoff at large coal handling facilities is unlikely because discharges into surface waters are regulated by federal and state regulations. On the federal level, the effluent requirements for the stream and power industry include:

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1. Total suspended solids in wastewater run-off resulting from precipitation, taken collectively including coal pile drainage, yard and roof drainage, and runoff from construction activities, shall not exceed average concentrations of 15 mg/1 (<0.01 oz/gal) during each runoff event, or a maximum concentration of 70 mg/1 (0.01 oz/gal) per day.

2. All stream discharge must have a pH value between 6.0 to 9.0 at all times.

Closed Coal Storage/Stockpile

Using enclosed bins and concrete silos to stock and store coal will eliminate water quality impacts, since no water will be permitted to come in contact with the coal.

Slurry Pipelines

The effect of coal on the water it is transported with can either be harmful or beneficial, depending upon whether pollutants are leached from the coal into the water, or if the coal absorbs pollutants from the water (20). Coal contains a number of components that can contribute pollutants to the water used as the carrier fluid. These include organic substances (particularly humic substances in lower rank coals), mineral matter (e.g., clays, alkaline earth carbonates, sulfides and silica), and trace elements. Coal may contain trace amounts of nearly every element found naturally existing in the environment. These elements may be associated either with the organic or mineral fraction of coal, and potentially may be leached from the solid coal into the slurry water. The extent of physical and chemical reactions between the coal and the water depend upon the characteristics and composition of the coal and the water.

Laboratory tests reported by Moore (32) found the following quality parameters to be present in highest concentrations in slurry wastewater using coal samples from several mines in Wyoming: alkalinity, biochemical oxygen demand, calcium, chemical oxygen demand, chloride, magnesium, nitrate, potassium, silica, sodium, sulfate, and total hardness. The concentrations of several parameters in Moore's study were below the detectable limit of the test procedure used. These included chromium (0.1 µg/ml), copper (0.09 µg/ml), iron (0.12 µg/ml), manganese (0.055 µg/ml), mercury (7.5 µg/ml), phosphate (0.01 µg/ml), and zinc (0.018 µg/ml).

Coal-derived oil is being studied (29) as a carrier fluid for slurry pipelines. If employed, the oil could be utilized as fuel with or without processing prior to burning, depending on environmental controls. Subsequently, the wastewater problem would be reduced if not eliminated.

Environmental impacts from potential pipeline breaks are site specific. A pipeline break over land would have little effect on groundwater, as most of the coal particles would be filtered by the soil. If water, other than fresh water, or a coal oil derivative is used as the carrier fluid, the impact may be more severe depending on the quantity and quality of the release.

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No effluent resulting from the use of coal-slurry is discharged directly into natural waters, but is usually disposed of by evaporation. A possible impact, although slight, might be the attraction of migrating water fowl to these ponds. Chemicals used in the clariflocculation process for corrosion inhibition of pH adjustment could prove to be harmful to these birds. A way to minimize this impact would be to carefully choose chemicals to aid in coagulation and corrosion inhibition, or to neutralize the chemicals after the job is finished (18). Some coal slurry pipelines may terminate in areas where the effluent cannot be disposed of by evaporation. In this case, the effluent must be treated as an industrial waste, and discharged in accordance with required standards. Another alternative is to recycle the effluent to the origin of the pipeline.

Construction of Transfer/Terminal Facility

For construction of a transfer/terminal facility near a waterway (river or lake), dredging for dock construction will usually be necessary. The environmental impacts of dredging are short-term. Temporary water quality impacts include the following: (34, 35)

- Bottom-dwelling organisms are destroyed or displaced.
- Release of bottom nutrients can cause algal blooms.
- Reduction in dissolved oxygen levels from various chemical additions from newly exposed sediments.
- Increased turbidity, which might inhibit photosynthesis and further depress dissolved oxygen levels.
- Settled sediment transported by waterway currents may affect benthic organisms in nearby areas.

Grading of the construction site is also a source of water quality impact which may result in the following:

- Increase in sediment runoff to receiving streams;
- Increased sediment loads and increased turbidity in receiving streams may result in decreased photosynthetic activity, thereby reducing dissolved oxygen levels;
- Discoloration of the water could disrupt recreational uses of the waterway downstream.

Spraying of Water and Other Chemicals for Dust Suppression

Small quantities of water may be used to control dust emissions from loading, unloading, stacking, reclaiming, and conveyor transfer. The wastewaters resulting from the quantities of water used for dust control are small compared to runoff/leachate from piles, and therefore, have little environmental significance (37).

WATER USE

Slurry transportation of coal requires large quantities of water, although these amounts are less than would be required for most minemouth utilization of coal. Pipelines that are relatively short may recycle water and use a water make-up system. When the pipeline is long, as is the case in the existing Black Mesa pipeline, and for most of the facilities proposed for other locations, adequate water resources must be available. The quantity of water required for slurry preparation depends upon the volume of coal to be shipped, and the water to coal ratio. Operation of the Black Mesa pipeline requires 3.9 million m^3 (139 million cu.ft) of water per year. The additional demands for water required by slurry pipelines may require diversion of water from existing streams, underground aquifers, or from other uses possibly resulting in significant environmental impacts. In western states, obtaining the necessary water rights may be rigorous, although recently it has been found to be a readily available fluid in those areas (19).

Water requirements are a major disadvantage of coal slurry pipelines, however, as reported by Godwin and Manahan (20), "the generation of electricity at the mine site or conversion of the coal to a liquid or gaseous fuel requires more water than does slurry pipeline transport. For example, generation of 1 million Btu's of electrical energy at the mine site requires 379 liters (100 gal) of water; on-site generation of synthetic natural gas with the same energy content requires 114 liters (30 gal) of water; and only 45 liters (12 gal) of water is required for the slurry transport of coal with an equivalent amount of energy."

In summary, the large volume of water required for slurry preparation and transportation will have an impact on the following:

- Existing water use pattern
- Availability of water for other uses (e.g., agriculture, power generation, industrial use);
- Alteration in ground and surface water hydrology and flow regime
- Interbasin transfers may be required

However, the impacts will be site specific and may be severe in areas where limited water resources prevail. In order to overcome this difficulty, studies are being conducted to determine the feasibility of using alternate water supply sources in slurry transportation. These include municipal wastewater plant effluents, industrial waste effluent, sea water, and saline water from deep wells. Even though the use of sea water provides an unlimited supply for slurry preparation, the technical difficulties to combat corrosion in boilers and scrubbers would be significant and limited by the tolerable chloride concentration in dewatered coal cake.

One benefit of using water as a carrier fluid in coal transfer is the availability of the slurry water for potential reuse in terminal facilities. At

the Mohave power plant, the treated slurry water is reused as cooling tower make-up water (33). The slurry water may also be suitable for use in irrigation or for non-contact recreational purposes. Discharge of the water into receiving waters requires that it meet pollution standards. These problems may be aggravated if low-grade groundwater is used for slurry transport.

AIR QUALITY

General

The extent to which the ambient air quality will be affected by coal transfer operations and terminal facilities will depend primarily on the equipment, storage, and transportation facilities used at each installation. In general, air emissions that are common to most transfer/terminal operations occur in the form of fugitive dusts from open storage and from spillage during transfer. In addition, fugitive dusts are also generated from traffic around terminal facilities. Minor quantities of gaseous pollutants are also released to the atmosphere from coal storage piles and from fuel combustion (diesel) in trains, trucks, and barges.

Coal storage could be the major source of total suspended particulate (TSP) emissions. Other significant transfer operations which should be considered in evaluating air quality impacts from transfer/terminal facilities include:

- Loading and unloading operations
- Movement of coal within the terminal (e.g., conveyors), and
- Uncontrolled combustion of coal and release of gaseous pollutants

Emission of gaseous pollutants from diesel engines and accidental spontaneous combustion at coal storage piles is generally infrequent and should not cause a significant impact on prevailing air quality. However, the release of fugitive dust emissions from coal handling and vehicle movement is semi-continuous in nature, and therefore, is significant for environmental impact analysis. The fugitive coal dust can deposit on neighboring plants and leaves thereby inhibiting their photosynthetic capabilities. The accumulation of coal dust on vegetation and soil can be harmful to wildlife feeding on the vegetation, and can alter the soil permeability characteristics (35). However, these effects are suspected to be contained within the immediate vicinity of the terminal since the fugitive dust particles are usually large (median size 23), and quickly settle to the surface (39). The final environmental impact statement on the Fuel Use Act indicates that the projected increase in coal utilization (over one billion tons per year by 1985) will cause no significant regional degradation in ambient air quality, and the major impact will be site-specific and related to the construction of new terminals, highways, and railroad spurs (39). The report also projects that the majority of coal will be transported through railroad facilities.

Open Coal Storage

The amount of coal stored is a function of the type of facility operated. Average number of days coal supplies are maintained at various user categories follow: (4)

- Coke plants - 23 days
- Electric utility stations - 92 days
- Industrial facilities - 37 days

Fugitive dust (particulate matter) is emitted from open storage piles via wind and other weathering forces acting on the surface of the pile. This process is similar to the wind erosion of soil. Gaseous materials also emanate from coal storage piles by oxidation of the exposed coal and the release of pressure on the solid due to mining and comminution. Some volatile emissions are also generated during the weathering processes.

Oxidation of coal storage piles results in gaseous emissions such as hydrocarbons, ethane, carbon monoxide, and sulfur compounds. However, based on the results of sampling coal storage pile emissions at the surface and upwind, Blackwood and Wachter (4) found that the upwind concentration of these pollutants as a gas were nondetectable.

Generally, particulate emission from open coal storage piles is influenced by several factors including:

- Meteorological conditions (e.g., wind, speed, humidity and temperature)
- Local topographical conditions
- Surface area of the coal pile
- Pile geometry
- Moisture content and bulk density of the coal
- Length of storage and condition of crust formation
- Regional precipitation
- Coal size
- Coal erodibility (dustiness)
- Mitigative measures taken to control fugitive dust emission

According to Blackwood and Wachter (4), the particulate emission factor for a coal storage pile has been shown to be 6.4 mg/kg-yr (0.1 oz/lb-yr).

Reportedly, this average emission factor describes the emissions within 108% at the 95% confidence level. The major influencing factor was found to be the Thornthwaite Precipitation-Evaporation (P-E) Index which is a combination of the effect of humidity, precipitation and temperature.

The dispersion of fugitive dust in a downwind direction will vary with wind velocity, existing barriers (embankments, dikes, vegetation), and the fall-out characteristics of the particles. Previous studies conducted by EPA (35) have shown that at an average wind speed of 5 m/sec (16 ft/sec), only 40% of the particulate matter with a settling velocity of 5 cm/sec (0.2 ft/sec) would remain dispersed at a downwind distance of 1 km (0.6 mi). At 10 km downwind, only 17% of the particulates are expected to remain in suspension. The settling velocity of 5 cm/sec (0.2 ft/sec) is a conservative estimate for fugitive coal dust particles with a median mass diameter of approximately 25 microns.

Loading and Unloading Operations

Most loading and unloading operations result in the release of coal dust and particulates. The quantity of particulate matter emitted from loading and unloading operations depends on the rate of flow of coal (design capacity), coal size, moisture content of coal, and the type of installation. If the transfer operation employs silo storage systems and enclosed conveyors, the particulate emissions should be low from the facility. However, for open coal storage piles with truck unloading and the rotary bucket reclaiming system, particulate emissions may be significant. In addition to release of coal dust particles from transfer operations, particulate emissions will also be generated from loaded vessels (trains, barges, ships, etc.) waiting for shipment. These effects will be additive to those resulting from transfer operations themselves.

Slurry Pipeline Facilities

Fugitive dust emissions at slurry preparation sites may result from coal crushing and coal transfer operations. These particulate emissions can be effectively managed by providing suitable enclosures.

Fugitive dust emissions at the slurry recovery terminal may occur during drying operations. Operating experiences at the Ohio terminal (currently not operational) indicate that the flash dryers used for evaporating surface moisture from dewatered cake was dust prone. However, no health effects were experienced from these facilities, and the impact was primarily a nuisance impact. Coal slurry evaporation ponds may also be a source of fugitive dust due to aerosols from evaporation and airborne coal fines.

A pipeline break may cause fine particles of coal to be spread over the surface of the soil. These fine particles may be a source of fugitive dust. Coal-slurry discharged to holding ponds and evaporation ponds may also be a source of fugitive dust.

NOISE

General

There are three basic sources of noise which radiate from coal transfer operations and terminal facilities:

1. Vehicular movement and traffic noise (e.g., trains, towboats, ships, trucks)

2. Coal handling equipment (e.g., conveyors, crushers, bulldozers, stackers, reclaimers)

3. Coal impact noise.

The environmental impacts of noise from transfer/terminal facilities will depend upon:

1. Quantity and quality of noise generated.

2. Distance of the source (facility) to residential or natural communities.

3. Ability of surrounding terrain to buffer noise.

4. Existing land uses in the vicinity of the site (residential, commericial, or industrial).

Reportedly (34), both sudden and periodic noises may affect animals behaviorally and physiologically. In extreme cases, loss of hearing through inner ear damage has been observed in laboratory mammals. Furthermore, high levels of noise for fairly short durations have produced significant effects on sexual function, blood chemistry, auditory function, and susceptibility to seizures. Neural and hormonal processes may be stressed. Since acoustic signals play a major role in survival, viable behavior and population dynamics may be disturbed if communication is obscured by background noise.

Vehicular Movement and Traffic Noise

Table 2 presents a summary of estimated noise levels of unit operations within coal transfer/terminal facilities. Although the operations described in the table do not include all of the equipment outlined above, the major sources of noise at a transfer/terminal facility, i.e., operations that result in coal impact noise, bulldozer, and construction activities, are quantified.

Trains--

Noise resulting from train movements is a complex mixture of sounds generated by many different pieces of equipment and operations. Sources of noise in a moving diesel-electric locomotive are listed below, in descending order of noise level:

TABLE 2. ESTIMATED NOISE LEVELS OF UNIT OPERATIONS WITHIN COAL TRANSFER/TERMINAL FACILITIES

Unit Operation	Noise Level dB(A)	Distance (m)	Reference
Unloading Train			
Bottom dump*	59	12	(38)
Rotary dump	60	12	(38)
Loading Ship			
Shuttle conveyor**	75	15	(38)
Storage			
Stockpile conveyor	65	15	(38)
Bulldozer activity and reclaiming process	75-95	15	(38)
Construction Activities			
Pile drivers	100	15	(38)
Earth moving equipment and smaller stationary equipt. (compressors, generators, etc.)	75-90	15	(38)
Reclamation Equipment***			
Feeder	75	0.9	
Vibrator	110	0.9	
Operation Facility****	77	15	(35)

*This is an estimate for the rotary dump unloading facility based on the bottom dump facility. Both methods produce noise from coal impact, ventilation systems, and winches for car positioning.

**This is an estimate based on comparison with a traveling stacker.

***105B feeder and P160 vibrator manufactured by Eriez Magnetics, Erie, Pennsylvania.

****An estimate of total noise generated by a barge loading facility on the Ohio River, Burlington, OH. Equipment includes large trucks, loaders, bulldozers, truck dump, barge-loader, vibrating screens, crushers, conveyors, motors, fans, motor noises from tow boats.

- Horn
- Car coupling
- Diesel exhaust muffler
- Wheel/rail interaction
- Electrical generator
- Bells/whistles

Sources of noise in electric locomotives are:

- Horn
- Cooling blowers
- Wheel/rail interaction
- Electric traction motors

Towboats--

The only significant source of noise generated by towboats is due to horn blasts. Propulsion noise is usually radiated into the water and hull noise is usually of low frequency. The noise levels from towboats associated with barge and ship terminals probably cause little impact on the surrounding community (35).

Trucks--

Noise levels attributable to the operation of trucks originate from the engine, exhaust, cooling fans, and tires. The major source of noise from trucks is the exhaust, which can reach levels of about 100dB.

Coal Handling Equipment

Several different pieces of equipment within the transfer/terminal facility are used to load, unload, transfer, and stockpile coal. This equipment in turn has different noise levels associated with it. A list of noise sources is included below:

- Truck dumps
- Motors
- Fans
- Winches for rail car positioning
- Barge/ship loaders
- Rotary dumpers
- Conveyors
- Crushers
- Feeders
- Bulldozers, loaders
- Stackers/reclaimers

- Ventilation systems

Coal Impact Noise

Coal impact noise from a transfer/terminal facility originates when coal is dropped from rail cars unloading, either by bottom-dump or rotary-dump facilities, or is dropped into empty rail cars, ships, barges, conveyor transfer points, and storage bins.

The noise level generated by coal impacting with receiving equipment mostly is related to the material on which the coal is dropped. Proper housing and covering of facilities can greatly reduce the amount of noise generated from coal impact.

Slurry Pipeline Facilities

The operation of coal slurry transfer pipelines is not expected to generate any noise pollution. However, significant noise levels may be generated during construction and dismantlement. Noise pollution at slurry preparation facilities (e.g., crushers, pulverizers, etc.) will be minimal if proper housing, enclosures, and exhaust control systems are incorporated (18).

AESTHETICS

Aesthetic impacts can occur during construction, operation, and abandonment of coal transfer unit operations and transfer/terminal facilities. A major aesthetic impact of transfer/terminal operations will be caused by disruption of the horizon with vertical obtrusions. The use of vertical equipment (conveyors, stackers, reclaimers, loading terminals) and coal storage piles can reduce the visual attractiveness of the site and the surrounding area. Coal stockpiles and other storage facilities, particularly large silos, may be noticeable for significant distances from the site. Conveyors, stacker/reclaimers, and other equipment also are elevated often to heights which would restrict views. Another aesthetic impact may be caused by fugitive dust fallout because of the dark color of coal. Such dust is usually visually displeasing.

Aesthetic impacts are site-specific to the type of facility, equipment used, and the nature of the surrounding area (residential, rural, or industrial). A large factor determining the extent of the impact on the community will be determined by the ability of the population to adjust to changes in the visual appearance of the horizon.

LAND USE

Transfer operations that are part of mining facilities, utilization facilities, and other coal handling facilities not used primarily for the transfer of coal, represent minor land use impacts because they are an integral part of that facility. The vast majority of such facilities is located a significant distance away from heavily populated and residential areas. This

point is emphasized by the planning and construction of minemouth coal-fired electrical generating stations near western mines. For similar reasons, such facilities also occupy sites with sufficient land acreage to support transfer operations without additional major environmental impacts. When located in incorporated areas having zoning laws, facilities using coal are located in areas zoned for heavy industry--another factor that limits land use.

Land use impacts may vary depending upon the type of transfer equipment and methods employed. For example, open storage and stockpiles require significantly more land space than silos, a fact that tends to increase siting options.

At facilities designed to use coal, land use impacts are usually minor compared to those of the primary facility i.e., slurry preparation and dewatering facilities which are attached to the associated mining and utilization facilities, respectively. Facilities originally designed to use oil or gas, which require less space for fuel transfer operations, may cause more serious land use impacts if converted to coal. In such cases, coal handling facilities may be forced to occupy a space smaller than that normally used, and/or the facility must acquire additional space.

Land use impacts for facilities utilized primarily for the transfer of coal from one mode of transport to another are site specific and differ depending on the type of facility and equipment used. Barge/ship loading facilities are independent facilities requiring space near water. The amount of space depends heavily on the amount of coal storage space required and the type of storage used. Barge/shiploading facilities that handle wet coal (received from slurry pipelines or barges) may require sufficient space for water treatment and handling systems.

Coal transfer/terminal operations and facilities will cause little, if any, long-term land use impacts. When abandoned and dismantled, most facilities can be returned to their original land use. Varying degrees of reclamation will be required.

SECTION 6

CONTROL TECHNOLOGY

GENERAL

This section describes currently available control techniques and mitigative measures that may be used to reduce adverse impacts on the environment caused by coal transfer/terminal operations. The control techniques are discussed in terms of the benefits on the environment as follows:

- Water use
- Water quality control
- Air quality control
- Noise
- Aesthetics and land use

Since the activities relative to the construction of new facilities and abandonment of existing operations are short-term and temporary in nature, separate discussions are included for these activities.

Before discussing other control methods and systems, it should be noted that perhaps the best means of minimizing environmental problems is to incorporate environmental planning in early designs. For example, how and where coal will be stored, the number and types of piles, and types of stacking and reclaiming equipment are major decisions. Coal storage should be designed to meet the objectives of the facility. The facility should be arranged so that additional storage can be easily added at a later date if necessary (8, 17).

WATER USE

Coal slurry transportation depends upon the availability of carrier fluid (water) in sufficient quantities. Using availability of the carrier fluid as a major criteria for site selection may minimize water resource impacts. In addition, alternate water supply sources should be investigated at each site, either to supplement and/or substitute identified available freshwater supplies. Alternatives might include surface water, groundwater, saline water from deep wells, salt water from the sea or lakes, municipal wastewater, and industrial wastewater. Investigations are currently in progress to determine

the feasibility of using sea water as a carrier fluid. The tolerance values for chlorides and total dissolved solids will dictate the dilution water requirements for sea water utilization. Fluids other than water should also be considered. (Examples of potential usable fluids are naturally existing and coal derived liquid hydrocarbons.) The concept of creating a liquid hydrocarbon carrier from coal at the pipeline's point of origin would be appealing, provided more water is not required for the process than that required by a coal-water slurry pipeline. The economics of liquification are poorly understood, consequently further research is needed in this area (18). In summary, the impact on water resources from coal slurry pipelines could be minimized by judicial site selection of terminal facilities, and by considering all possible water alternatives and the potential for using a non-water carrier fluid.

WATER QUALITY CONTROL

In general, the control techniques available for reducing the impact of wastewater resulting from coal transfer operations can be classified into two categories as follows:

- Techniques that are effective in reducing runoff/leachate flow and characteristics (source control).
- Techniques that are effective for removing pollutants from run-off/leachate wastes (collection and treatment).

Because the wastewaters generated from coal pile storage areas (runoff/leachate) and from air pollution control devices (e.g., dust suppression, scrubbing, etc.) are usually similar in characteristics, most terminals handle and treat these wastes jointly.

Source Control

Water quality impacts from coal handling facilities are primarily a result of coal-water interactions occurring within the terminal. The sources of water are the various forms of precipitation and the water sprays used to control particulate emissions. The quantity of water used for dust control purposes may vary between 4 to 10 liters per metric ton (1 and 2 gal per short ton) of coal processed at the facility (37). Dust control is accomplished by strategic placement of nozzles. A chemical additive is generally used in the spray water to aid the formation of a crust on the coal surface. These chemicals are usually water soluble polymers (acrylics) and are mixed in dosages as recommended by the supplier (11). Excess water applied in the spray system is usually collected and joined with other run-off from the plant site.

In general, there are several principal sources of wastewaters from coal transfer/terminal facilities. They include:

- Runoff from coal storage area
- Leachate from coal pile drainage

- Excess spray waters used as a dust suppressor

- Wastewater resulting from the interaction of coal dust fall-out, and spillage from transfer operations with precipitation and surface waters

Various source control techniques have been developed to reduce coal-water interaction. Table 3 provides a summary of some source control techniques and their advantages and disadvantages.

Employing structural barriers usually involves a large capital investment. Silos and enclosed bins are examples of structural barriers. Since these structures separate the coal from the environment, precipitation does not contact the coal.

An alternative to the use of enclosed structures is water insoluble chemicals. Coverings that have been used include cut-back asphalt, asphalt emulsion, and road tar (2). Reportedly, asphalt emulsions (25-40% water) are superior to other covering materials. The material is heated to about 49-65^{o}C (120^{o}-150^{o}F) and can be applied by spraying through a hand nozzle. In addition to reducing water problems, these barriers are also effective in controlling wind erosion from coal piles. Use of asphalt-type materials or tarpaulins has been studied at several installations. Careful consideration should be given to the use of asphalt or tarpaulin because of the possibilities for increasing the potential of spontaneous combustion, and the possible development of the "chimney" effect.

Another type of source control is to adjust the quality of waste stream before it leaves the source. For example, readily available sand, oyster shells, and clamshells were used as the base for the coal pile located at a barge-to-barge terminal on the Mississippi River. Using these materials provided a natural neutralizing effect to counter acidity of water percolating through the coal (15).

Collection and Treatment

The collection and treatment of wastewaters is practiced in many terminal operations. Typically, coal pile runoff is directed to an ash pond or a catch basin by drainage ditches, and subsequently treated. Treatment usually includes pH adjustment and removal of suspended solids, but often requires the addition of settling aids such as lime or polymers followed by clarification in order to remove the suspended or precipitated solids (28).

An investigation by Metry (29) reported that in the case of western coals containing low pyritic sulfur, usually it is necessary only to remove suspended particles to meet EPA effluent guidelines for the steam and power industry. However, for eastern coals containing high pyritic sulfur, the treatment process should neutralize excess acidity, precipitate heavy metals, and as well remove excess suspended solids. According to Metry (30), the basic approach for treating leachate and contaminated runoff would consist of the following:

TABLE 3. SUMMARY OF SOURCE WATER CONTROL TECHNOLOGY

Control Technology	Advantages/Disadvantages
Open-sided shed storage with perimeter containment	Low capital cost
Tarpaulin	Can promote spontaneous combustion
	Suitable only for small storage pile
Sealing coal pile with asphaltic spray*	Provides control against water contact as well as dust emission
	Can promote localized combustion unless sealant cover is applied on top as well as on side slopes to prevent "chimney" effect
Sealing coal pile side slopes with earth	Effective in reducing water-coal contact as well as wind erosion
Application of chemical binders runback and polymers (e.g., acrylics)	Effective in controlling wind erosion
	Coal-water contact is only minimized by formation of a crust on coal particles
	Less expensive than asphalt spray
	Easy to handle and spray
	2 to 3 applications over the area were effective in preventing contact with coal (90% of rainfall) (60)
Prevent oxidation of pyritic and marcasite coal by preventing air circulation through the coal pile	Will reduce leaching of sulfur and iron compounds
	Will reduce acidity in leachate/run off (9) (96)
- Increase coal size or reduce surface area	Will reduce treatment requirements for leachate/run-off
- Coating coal with oil	
- Store aged or weathered coal	

*Sealant requirement depends upon coal pile permeability, coal size; may be minimized by covering the pile with fines up to 0.3(ft) deep.

1. Segregation of contaminated runoff and leachate from other water streams at the facility.

2. Providing sufficient storage capacity for holding contaminated runoff and leachate prior to treatment.

3. Treatment of contaminated runoff and leachate for suspended solids and heavy metals, if present, prior to discharge to the receiving water body.

4. Providing sufficient storage capacity of treated waters for polishing the effluent.

5. Utilization of as much treated wastewater as possible for dust suppression at different points in the coal-handling facility.

6. Recovery of coal fines in the contaminated runoff and leachate from the settling and precipitation facilities.

Table 4 summarizes typical treatment systems that are currently being used to control leachate/runoff waters from coal storage piles.

The use of storage ponds or catch basins as the only means of control is effective only in reducing suspended solids. These ponds are usually designed to handle approximately a 15-20 day storm with a recurrence interval of 25 years (27). If the ponds are designed carefully to prevent short-circuiting, they are very effective in meeting concentration limitations of effluent suspended solids. Drainage from some coals, particularly eastern coals, may require neutralization prior to discharge. Depending upon the characteristics of leachate and discharge limitations, the catch basin (clarification) treatment followed by pH control could provide efficient wastewater treatment. The current regulations governing the discharge of coal pile runoff waters from mining point sources are summarized in Table 5.

Laboratory-scale studies have been conducted using advanced wastewater treatment systems such as reverse osmosis. These studies indicate that the reverse osmosis process is effective in removing multivalent ions from mine drainage. All heavy metal ions are removed at approximately the same level (99+%). Water recoveries of approximately 90% are achievable (22,23). While effective, reverse osmosis would incur very high capital and operating costs.

Construction Activities

Construction of transfer/terminal facilities may require excavation, consolidation, landscaping, surface preparation for coal pile storage, and dredging in existing waterways. Water quality impacts during construction occur primarily from sediment transport and soil erosion during storm events. When these sediments enter waterways, local turbidity, discoloration, and reduction in photosynthetic activities may appear during the construction period. Effective control of erosion and sediment transportation can be accomplished by preventing direct entry of runoff waters to the receiving waters. The storm runoff water can be collected in diked areas to form a retention basin where the

TABLE 4. TYPICAL TREATMENT SYSTEMS

Collection and Treatment	Advantages/Disadvantages
Catch basin with provisions to monitor overflow	Effective only in reducing suspended impurities Not suitable for reducing acidity and 'yellow boy' problems or for heavy metals
Collection and reuse of runoff/leachate for spray systems	Treatment required only for reducing suspended particles to protect against nozzle clogging
Pit and berm storage of coal	Provides positive containment of runoff/leachate Improves aesthetic appearance; visible height of coal pile is reduced

TABLE 5. COAL STORAGE RUNOFF REGULATIONS*

Coal Mining Point Source						
	BPCTCA		BATEA		New Source	
Parameter	Max 1 Day	Avg 30 Days	Max 1 Day	Avg 30 Days	Max 1 Day	Avg 30 Days
Total Fe	7.0	3.5	3.5	3.0	3.5	3.0
Total Mn	4.0	2.0	4.0	2.0	4.0	2.0
TSS	70	35	40	20	70	35
pH	6-9	6-9	6-9	6-9	6-9	6-9

*All values are mg/l except pH

Source: Weeter, D.W. Coal Pile Water Quality Management - Results of a National Study. In: Proceedings of the 33rd Industrial Waste Conference, Purdue University, May 1978. p. 302.

turbidity will be removed. In general, the following control methods will be effective in controlling sediment transport:

- Provide catch basins and retention dikes
- Plant fast-growing cover crops (e.g., rye grass) to stabilize barren or disturbed areas.

Dredging to remove bottom sediments may be required when docking facilities are to support ships and barges. Excavating bottom sediments in a restricted dock area will produce localized short-term temporary upsets to local aquatic plants and animals. In addition, temporary visual effects will appear because of the increased turbidity. Subsequent deposition of suspended materials may smother or suffocate certain aquatic organisms. The following control technologies are available to reduce the impact due to dredging:

- Use of a floating turbidity curtain to contain turbid suspension in the immediate vicinity.
- Use of a different dredging equipment (e.g., mechanical or suction-mechanical) with increased sediment removal efficiency.
- Proper scheduling of the dredging event to minimize environmental stress on aquatic life.

SITE ABANDONMENT

Abandoning coal transfer/terminal facilities involves removal of existing railroads, dock facilities, conveyors, and other structural features. Equipment may be sold or reused and the steel recycled.

Belt conveyors are usually supported on concrete piers which are usually abandoned rather than removed. Removal of all steel and concrete structures with subsequent grading and reseeding will restore the land to its original state. Similarly, abandoned roadways can be reclaimed in a manner suitable for reestablishing original vegetation and plant life. This will also reduce the impact on receiving water quality due to erosion and sediment carryover. Renovation of a coal pile storage area can be accomplished by the following manners:

- Gradual removal of coal dust with runoff waters. This will require continued operation of existing treatment facilities until the coal dust particles mostly have been removed.
- Regrading the coal pile storage area with fresh top soil, and re-establishing original cover crops and plants.

AIR QUALITY CONTROL

Methods of controlling air pollutants during the operation of coal transfer/terminal facilities can be categorized as:

- Enclosed systems
- Water or chemical sprays
- Surface coatings
- Dust collection
- Containment equipment
- Compaction
- Barriers
- Others

In addition to the above, prevention of pollution sources can be considered a control method. There are two opposite yet correct methods of preventing spontaneous combustion. One is to encourage air circulation to remove heat of oxidation and prevent a dangerous heat build up. The other is to prevent contact between oxygen (air) and coal. Air circulation can be augmented by increasing the surface area/volume ratio of the coal pile; many small piles instead of one large pile has been suggested (28). However, this increases the coal pile runoff, and because of increased coal oxidation, increases the concentration of water effluents. Air circulation can be prevented by coating the piles with sealing materials. Adequate precaution should be taken to prevent the "chimney" effect, which results when there are breaks in the sealed surface.

Enclosed Systems

Partial or complete enclosure of all operations at a transfer/terminal facility will reduce or prevent air quality impacts (21, 34, 38, 37, 17). Enclosures can be designed for most equipment and facilities including transfer towers, rotary car dumpers including positioners and feeder hoppers, dockside loading barges, coal screens and crushers, coal stockpiles (e.g., silos), and conveyors. Bins receiving coal from trucks can be enclosed by three side panels and a sloping roof. Curtains can be hung to partially close the remaining opening while a truck is dumping. Enclosures are often serviced by dust collectors.

Water or Chemical Sprays

Water (with or without a chemical additive), sprayed directly on coal, reduces the quantity of airborne dust. Chemical compounds and foams may also be used. Application of the spray occurs at designated points, and include (1) directly onto the stockpile at each transfer point in a conveyor network, and

(2) in the rotary dumper prior to discharge (34, 27). The use of water on a stockpile may increase the occurrence of hot spots. Changes in wetness of the coal affect ventilation of the pile and heating activity of the pyrite, and require that the coal be dried prior to combustion. Thawing and shaking equipment must be available in areas which experience freezing temperatures. Non-toxic chemical sprays have been developed to control airborne dust while simultaneously providing protection against freezing temperatures, thus reducing the need for thawing equipment (4, 36, 37). Sprays do not function well at bin-loading operations because the area is so large and the dust surge is violent and intermittent.

One advantage of wet suppression systems over dust collection systems is that the dust is never removed from the product stream. Disadvantages of wet suppression systems include: (26)

1. The moisture content of the coal/lignite increases, reducing the Btu/ton available at the boiler.

2. Air displaced or entrained with the coal/lignite at conveyor transfer points is not contained.

3. Frequent maintenance is required.

4. Chemical additives or foaming agents are costly.

Surface Coatings/Coverings

Crusting agents, cappings and coverings prevent air from entering the stockpiles, thereby reducing the potential for spontaneous combustion, and the quantity of fugitive dust emission. Water-soluble acrylic polymers which leave a clear, tough, dry film on the coal surface are among the crusting agents currently in use. These polymers provide protection from wind and rain for several months, hold the coal firmly in place while providing minimum friction in coal handling, and burn off entirely at 538 ^{o}C (1000 ^{o}F).

Portland cement, plaster of paris, oils or salt sprays, asphalt, and tar derivatives are types of capping agents which control particulate emissions. Asphalt, one of the more common capping materials, applied in emulsion form, can be heated to 52-66 ^{o}C (125 ^{o}-150 ^{o}F) in a tank wagon and sprayed through hand nozzles directly on the stockpile (27, 17). Cut-back asphalts prevent coal dust nuisance, windage loss, and moisture penetration (2). The tar derivative causes the coal dust to adhere to the pile, however, when tar is sprayed onto a coal pile, particulates are emitted from the overspray (4, 17).

Both the asphalt emulsion and the tar derivative can be burned off with the coal. If the coal is to be pulverized, care should be taken during reclaiming of asphalt-capped coal, as too much asphalt will gum up the equipment. In areas with temperatures below -4 ^{o}C (25 ^{o}F), asphalt capping is not recommended because of tendency for the water to freeze.

Physical coverings such as tarpaulins and plastic covers are also used on storage piles to reduce air movement and minimize airborne dust (27). When tarpaulins are used to cover coal piles, frequent monitoring to locate hot spots will be necessary to protect against spontaneous combustion.

Dust Collection

The fugitive dust generated by transfer operations located in enclosed areas can be controlled by using a dust collection system or a device designed to prevent the generation of dust. These systems can be used to control dust inside buildings containing multiple operations. They can also be used to collect and control the dust from individual transfer operations or transfer points. Large enclosures often use central collection systems. The dust at individual transfer points is more economically handled by devices designed to collect and treat dust using a simple approach, such as filtering, or by employing devices that reduce or prevent dust from being generated. For example, an insertable dust collector has been proposed for conveyor transfer points that uses reverse jets of compressed air to force dust cake off the collectors and back onto the conveyors so that the coal dust stays within the coal handling system. Whenever possible, it is desirable to return the collected coal dust to the product line, thereby eliminating disposal problems and reducing product losses. The collected air stream containing the dust can be treated with control methods including fabric filters and scrubbers.

Containment Equipment

A major source of fugitive dust associated with coal transfer is the formation of stacking of open coal piles. Several devices are commercially used to reduce fugitive dust generated from free falling coal by protecting it from the influence of the wind as long as practical. Two such devices are loading stacks and chutes, which can be designed to be telescopic.

A loading stack is a tube having doors or shrouds located at different elevations on its sides. These doors are kept closed and selectively opened to minimize the distance the coal is to fall from the opening to the top of the coal pile. Minimizing the coal falling distance also tends to minimize fugitive dust.

Telescopic chutes are circular devices which can be adjusted to change the distance between where the coal is released and exposed to the atmosphere and the top of the coal pile. When used to load rail cars, ships, and barges, the chute travels to the bottom of each new car and raises as the car is filled. Water sprays may be used but are not common.

Compaction

Compaction of coal in open or closed stockpiles/storage reduces available pore spacing for air circulation and minimizes coal surface area exposed to the atmosphere. To ensure proper compaction, coal should be stored in the following manner:

1. Place the coal in thin lifts about 1 foot in depth.

2. Thoroughly compact each increment to break-up air channels and to reduce the air-to-coal volume ratio.

3. Maintain gently sloping sides (maximum slope about 14^{o}) on surface piles to minimize segregation and to facilitate thorough compaction of the pile sides.

4. Smooth the final surface to reduce the effect of wind in producing differential pressures and possible resultant air currents within the coal mass.

Barriers

Controlling the affects of wind on stockpiles and storage piles can reduce the quantity of fugitive dust generated. Barriers that can be used for this purpose are:

- Air-tight retaining walls
- Storage of coal in bins, silos, bunkers, earthen pits
- Storage underwater
- Wind guards for yard conveyors

To be effective, the height of such barriers must be greater than the height of the pile since wind will tend to project over the barriers and still impact on the coal pile.

A control method similar to the use of barriers is the use of pits or structures that are entirely or partially level or below surface. In addition to reducing fugitive dust from the coal pile, storing coal in a pit usually reduces the amount of coal spilled during loading and unloading. Spillage, because of the greater surface area exposed to the wind, permits faster drying of the coal, but may generate more fugitive dust than does the coal pile. Storing coal in pits requires additional design considerations for leaching and runoff. This may be reduced by providing containment of the coal and contaminated water, along with collection and treatment facility.

Other Methods

Minimizing the distance that the coal must fall through the air during transfer can control the quantity of dust becoming airborne. This can be accomplished by employing an adjustable boom controlled manually or with sensors to handle the adjustment automatically on equipment used for loading the coal (9, 10, 12).

Dust emissions may be reduced during the loading of bins by maintaining a negative pressure to provide a downward flow of air from the top of the bin.

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During construction of the transfer/terminal facility, the roads can be sprayed with water, paved and compacted, or excavated soils moistened to minimize airborne dust. Paving the road that leads to a proposed facility can result in 85% control of the particulate emission attributable to trucks (36, 37).

NOISE CONTROL TECHNOLOGY

General

Basically, there are two approaches to reduce or control noise levels generated from any source:

- Shielding, enclosing, or insulating the noise source from the surrounding area.
- Modifying the noise source through vibration isolation or by structural dampening. Modification of the noise source might also include equipment replacement.

The following section will identify both general and specific noise control procedures and technologies which can mitigate noise impacts from various unit operations within a coal transfer/terminal facility as described in the preceding chapter.

Noise from Vehicular Movement

Trains--

The U.S. Environmental Protection Agency (USEPA) has proposed regulations for train receiving yards in Noise Emission Standards for Transportation Equipment: Interstate Rail Carriers (40 CFR, Part 201).[1] The proposed receiving property standards for noise from the nation's interstate rail carriers, including railroad owned or operated terminal and storage facilities, and their related structures used for loading and unloading bulk materials, are stated below.

EFFECTIVE	HOURLY EQUIVALENT SOUND LEVEL	
DATE	DAYTIME	NIGHTTIME
January 1, 1982	84dB	74dB

In addition to the proposed regulations, the EPA identified several control technologies to reduce noise of receiving yards, included below:

[1] Federal Register/Vol. 44, No. 75/Tuesday, April 17, 1979/Proposed Rules.

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NOISE SOURCE	CONTROL TECHNOLOGY
Switch engine noise	Exhause muffling and cooling fan treatment
Retarders (master & group)	Sound barriers; retarder lubricating and ductile iron shoes
Inert retarders	Replace with releasable type
Car coupling	Speed control

The EPA also recommended that the standard maintenance procedure of grinding car wheels and rails to assure their roundness and smoothness be continued to reduce wheel/rail noise.

Other factors identified in the review of noise control technology to reduce train movement noise are:

- Absorbent material used in engine casing of locomotives (35).
- Reduction of wheel/rail interaction noise,
  1. Continuous welded rails (achieves noise reductions greater than 5dB)
  2. Resiliant wheels
  3. Rubber rail heads
  4. Rubber tires

Towboats/Ships--

Noise from towboats, that position barges for loading, and ships, is not expected to be of significant impact on the environment. However, use of mufflers on exhaust systems will eliminate most of the noise from these sources.

Trucks--

Insulation material should be used in engine covers and panels to reduce engine noise from trucks. Mufflers can easily reduce exhaust noise from 100dB to 90dB. Potential deductions of exhaust noise through research and development activities may achieve a 25% reduction in noise levels at approximately 15 m (50 ft). Possible control technologies would be to place a resonator close to the exhaust manifold; use exhaust pipe wraps, and double-wall or laminated exhaust pipes to replace conventional exhaust pipe systems (35).

Coal handling equipment--

In general, noise generated by loading, unloading, stacking/reclaiming systems, bulldozers, motors, fans, ventilation equipment, crushers, and conveyors can be reduced or controlled by proper maintenance procedures, reduced

operating speeds, and replacement of existing equipment with that which generates less acoustic energy. Shields, barriers, and enclosures can also effectively reduce noise generated by machine vibrations and coal impact noise with receiving equipment. Shields and barriers can achieve 8-10dB reduction per installation, while complete enclosures can achieve 12-15dB reduction (25).

Equipment such as conveyors, crushers, and truck or train dumps should be enclosed when possible. The degree of noise reduction from enclosures will depend upon the noise absorption and insulation properties of the material used for construction of the enclosure (38, 37). Bulldozers and other equipment utilizing combustion engines should install mufflers on exhaust systems, or use other exhaust and engine noise control technologies as suggested for trucks and trains above, where applicable. Also, bulldozer activities used for stockpiling should be limited to daylight hours wherever possible (34).

Coal Impact Noise

Noise emissions caused by sources such as: 1) receiving hoppers of rotary and bottom dump unloading facilities; 2) transfer points of conveyors; and 3) loading of empty rail cars, ships, barges, and trucks can be reduced by "softening", dampening, or preventing the impacts. Thus, the following controls should be considered (25):

1. Placing internal baffles in hoppers to encourage the coal to slide, rather than fall, onto hopper surfaces.

2. Changing chute slope to encourage sliding rather than bouncing.

3. Using soft materials (e.g., Neoprene) or dashpot buffers on chutes and hoppers to reduce noise from mechanical impacts.

4. Replacing metal conveyors at transfer points with canvas units, or reducing the height of the drops.

5. Lining conveyor sides with plastic or fiberglass railing.

6. Applying damping to the underside of conveyors, chutes, hoppers, etc.

7. Using telescopic chutes for loading transportation equipment to reduce the distance coal is dropped.

Generally, noise from all equipment and unit operations associated with a coal transfer/terminal facility can be reduced by enclosing the entire area with a manmade or natural barrier (e.g., trees and vegetation). The height of the coal pile storage will also act as a noise barrier, and will reduce overall noise from a facility (34, 37).

Aesthetics and Land Use

A major consideration for controlling aesthetic and land use impacts is the location of the transfer/terminal facility. Site selection criteria should

include consideration of landscaping and architecture (e.g., industrial site or park) which could blend with the proposed structural and non-structural features. Land use impacts should be minimal since the area considered for coal transfer facilities typically is zoned already for industrial facilities. However, disturbances to terrestrial and aquatic wildlife must be dealt with on a site-specific basis, and require environmental impact statements.

Enclosing the facility with a fence or berm may reduce the visual unattractiveness of the facility. In addition to a barrier, trees and shrubbery may be used to enhance the appearance of the area. Selective planting will create visual breaks in fence or berm, and thereby eliminate the monotony of the continuous barrier. Planting of vegetation should also accompany railroad lines and roads to lessen the visual impacts of incoming traffic to the facility.

Equipment which cannot be concealed by a barrier or selective planting should be painted with colors which permit the equipment to harmoniously blend into the surrounding scenery. Use of unobtrusive colors and color patterns can help to camouflage the equipment.

Barge transport has two associated major aesthetic impacts that are unique to this type of coal transport: 1) the appearance of a dammed river as opposed to a free-flowing river; and 2) the sight of barge movement on the river. These impacts may or may not be adverse depending on their physical appearance (e.g., landscaping, care with which barges are moved, color of structures) and individual taste. These aesthetic impacts may change as the use of barges increases.

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    Reports on a new barge-to-barge coal transfer terminal owned by International Marine Terminals. The terminal is being developed in three phases. Phase I has recently been placed in operation to meet a need for additional capacity in transferring coal from inland river barges (1500 ton capacity) on the Mississippi River to large barges (13,000 ton capacity) for movement across the Gulf of Mexico. Phases II and III will add ship loading capability and additional land storage. The components of the facility with Phase I completed are a river barge unloader, a fixed gulf barge loading boom, connecting conveyors and minimal land storage. Environmental controls are discussed.

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    The results indicate that (a) natural surface crusts are very effective in mitigating suspended dust emissions; and (b) a given surface has a finite potential for wind erosion prior to mechanical disturbance. Agreement was found between the erosion rate measured for uncrusted coal and the value obtained from a previously developed emission factor equation based on soil erosion data. The sampling scheme employed in this study is useful for quantifying the erosion rate dependence which in turn can be coupled with an analysis of wind flow patterns around storage piles to develop dust emission estimates for overall pile erosion.

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20. Johnson, A.W. Handling Western Coals and Lignite. In: Proceedings of the 2nd International Coal Utilization Conference and Exhibition, Vol. 1, Houston, Texas, 1979. pp. 209-232.

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A description with illustrations of the Black Mesa pipeline system including the coal slurry preparation plant and the four pump stations.

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Emission factors were developed for individual mining operations at five different western surface mines; the factors apply only to western coal mines. Upwind-downwind ambient sampling was used. Emission factors for transfer operations were found to be as follows:

1. Shovel/truck coal loading ranged from 0.002 to 0.014 lb/ton.
2. Truck with bottom dump ranged from 0.005 to 0.028 lb/ton.
3. Storage pile - (1.6μ) lb/acre-hr. where μ is in m/sec.
4. Train loading at one mine was 0.0002 lb/ton.
5. Front-end loader at one mine generated 0.12 lb/ton.

These values are initial emission rates and must be used in conjunction with a fallout function in predicting ambient air quality impact from a mine.

29. Roy F. Weston, Inc. Environmental Impact Report - Coal Transshipment Facility, Superior, Wisconsin. ORTRAN, Inc., 1974. 147 pp.

An EIR on a materials handling terminal for the City of Superior, Wisconsin. The terminal is designed to transfer from rail to barge up to 8 million tons per year of low-sulfur western coal via channel-side dock loading facilities to ports in the lower Great Lakes.

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Discusses several of the currently proposed coal slurry pipelines to illustrate the status of coal pipelines in North America.

34. U.S. Army Corps of Engineers. Final Environmental Statement - Rail-to-Barge Coal Transfer Facility, St. Louis, Missouri. U.S. Corps of Engineers, St. Louis District, 1976. 141 pp.

A final environmental statement on the construction of a 10 million ton/year coal terminal for transferring western coal from unit trains to river barges for transport to locations along the Ohio and Mississippi Rivers. The adverse environmental effects include the possible deterioration of ambient air quality from fugitive dust and the potential degradation of water quality resulting from coal spillage into the Mississippi River during barge loading.

35. U.S. Army Corps of Engineers. Final Environmental Impact Statement - Proposed Barge Terminal Expansion, Packer River Terminal, Inc., South St. Paul, Dakota County, Minnesota. U.S. Army Corps of Engineers, St. Paul, Minnesota, 1977. 69 pp.

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An environmental impact statement for a proposal to expand an existing barge terminal facility in South St. Paul, Minnesota. The adverse environmental effects include the loss of 22 acres of wetland serving water quality, food chain production and the degradation of air quality in the area from particulates, hydrocarbons and carbon monoxide. There would also be an increase in truck traffic (transporting coal) on arterial streets and highways and an increase in barge traffic on the Mississippi River.

36. U.S. Army Engineer District. Draft Environmental Impact Statement - Coal Transfer Facility at Ohio River Mine 314.5, Burlington, Lawrence County, Ohio. U.S. Army Engineering District, Huntington, West Virginia, 1977. 59 pp.

    A DEIS on the construction, operation and maintenance of a proposed coal loading facility consisting of a floating dock made up of two barges, a crusher and a conveyor system. Coal is delivered to the facility by truck over existing roads, dumped into a 25-foot square bin and moved by an enclosed conveyor to the crusher. The coal would then be moved by an enclosed conveyor to the barges. Potential adverse impacts include an increase in air pollution, water turbidity, loss of vegetation on plant site and associated wildlife.

37. Wachter, R.A. and T.R. Blackwood. Source Assessment: Water Pollutants From Coal Storage Areas. U.S. Environmental Protection Agency, EPA 600/2-78-004m, May 1978. 106 pp.

    Quantifies the effluent levels from coal stockpiles maintained outdoors by examining coals (both freshly mined and aged) from six coal regions in the United States. Effluent data were obtained by subjecting coals to rainfall from a simulation apparatus and collecting grab samples of the wastewater. The samples were analyzed for organic and inorganic substances and water quality criteria parameters.

38. Wachter, R.A. and T.R. Blackwood. Water Pollutants From Coal Storage Areas. In: Proceedings of the 2nd International Coal Utilization Conference and Exhibition, Vol. 1, Houston, Texas, 1979. pp. 233-239.

    Coal storage piles emit effluents due to the drainage and runoff of wastewater which occurs during and after precipitation. Effluent levels were determined in this study by placing various coals beneath a rainfall simulation device. Drainage from these samples was then collected and analyzed for a variety of pollutants and water quality parameters. Runoff effluent levels were estimated for a representative stockpile using a simple hydrologic model.

39. Weeter, D.W. Coal Pile Water Quality Management - Results of a National Study. In: Proceedings of the 33rd Industrial Waste Conference, Purdue University, May 1978. Ann Arbor Science, 1979. pp. 302-307.

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Results of a national survey of available water quality data on coal pile drainage were presented. Eighty utility companies were canvassed. Sixty-two responded to the questionnaire and 19 actually had studied coal pile drainage. The data is compared to water quality regulations and criteria.

Data is broken down into general surface water quality, surface water heavy metal quality, groundwater quality, and the effect of various treatment processes upon coal pile drainage. From a groundwater and surface water basis, various pollutants can be discharged via coal pile drainage. Effective treatment processes can be designed to control regulated parameters, however, little data has been generated relative to heavy metal and organics removal.

40. Winges, K.D. Assessing Impacts of Coal Mining Operations With Air Quality Models. Presented at the 72nd Annual Meeting of the Air Pollution Control Association, Cincinnati, Ohio, 79-34.3, June 1979. 13 pp.

Investigates techniques which have been adopted to make assessments of mining development. Concludes that impact assessment of mining operations using air quality models is in the early stages of development. Although initially assumed to be a simple task, the reality is now emerging that mine modeling is a difficult task with a host of different source types, frequent complex topographic influences, and emissions with deposition characteristics that require special treatment. This is further complicated by difficult measurement procedures and limited existing data bases.

41. Yu, A.T. World's Largest Ship-Barge Loading System Serves Coal Industry. Coal Age, January 1971. pp. 76-78.

Describes the ship-barge loading system operated by the B&O Railroad at Curtis Bay, Maryland. The facility is capable of simultaneously loading at the same pier ocean-going vessels at 6,000 tph and intracoastal barges at 4,000 tph. Coal is delivered to the pier by unit trains which are unloaded by a rotary car dumper.

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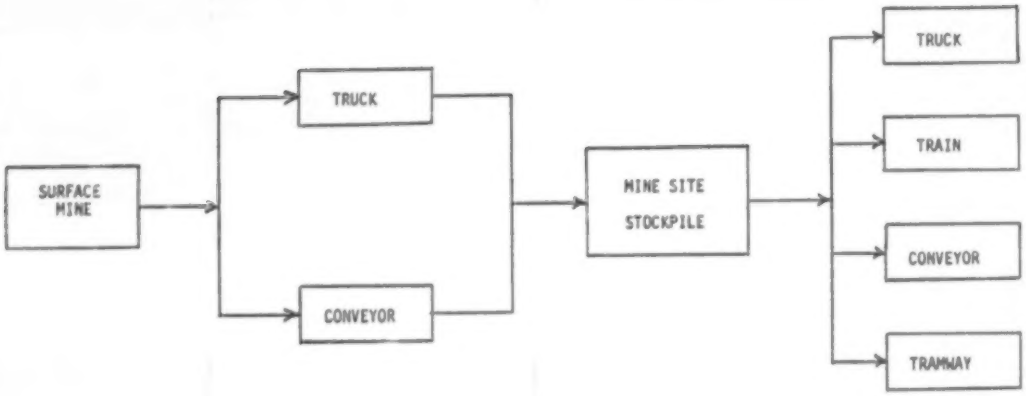
APPENDIX A

TRANSFER OPERATIONS AT SURFACE MINE SITE



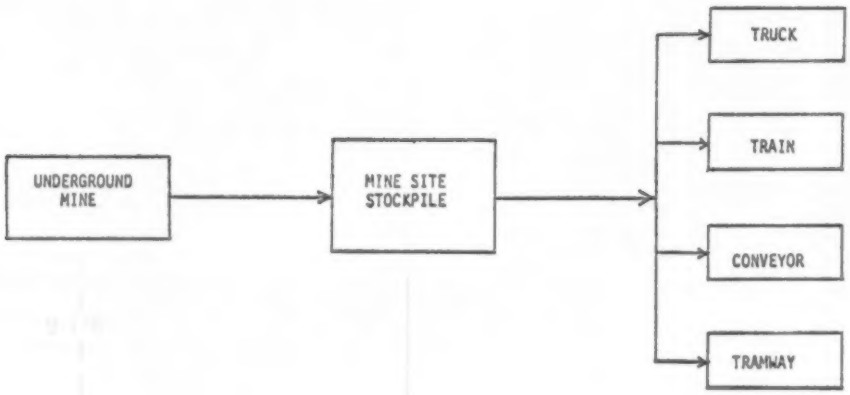
Major Transfer Points

1. Transfer from mining device to on-site transport device.
2. Transfer from on-site transport device to mine site stockpile.
3. Transfer from mine site stockpile to transport device that carries the coal from the mine site.

Transfer Facilities

1. Field conveyor system, if used.
2. Mine site stockpile and associated equipment.
3. Loading tunnel and/or other equipment.

TRANSFER OPERATIONS AT UNDERGROUND MINE SITES



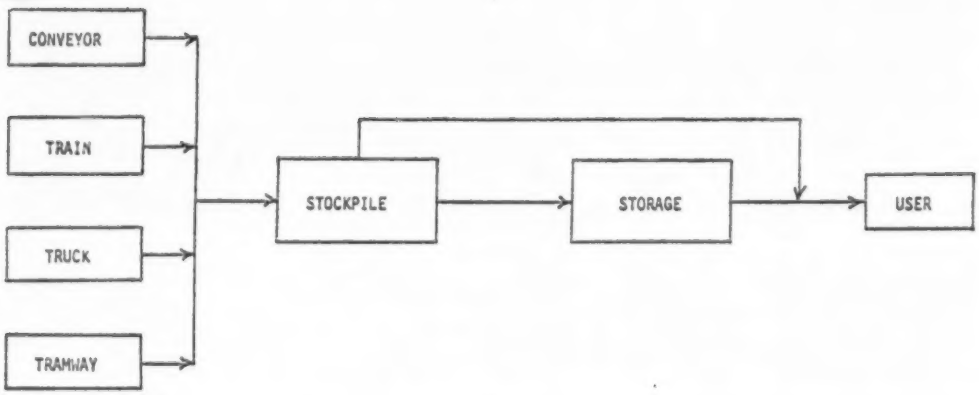
Major Transfer Points

1. Transfer from device that brings coal out of the mine to the mine site stockpile.
2. Transfer from the mine site stockpile to the transport device that carries the coal from the mine site.

Transfer Facilities

1. Mine site stockpile and associated equipment, i.e., open stockpile, silo, hoppers.
2. Loading tunnel and/or other equipment.

TRANSFER OPERATIONS AT INDUSTRIAL USER



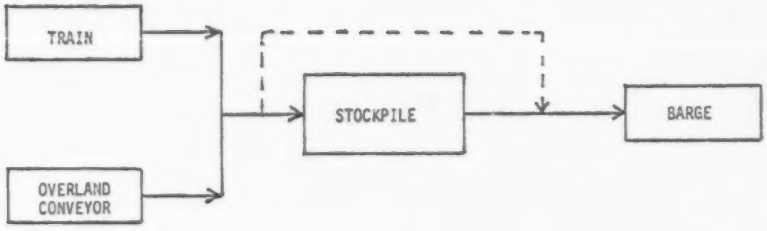
Major Transfer Points

1. Transfer from arriving transport mechanism to mine site stockpile or storage.
2. Transfer from stockpile or storage to utilization facility.

Major Transfer Facilities

1. Stockpile/Storage
2. Unloading system for arriving coal

TRANSFER OPERATIONS AT BARGE LOADING FACILITY



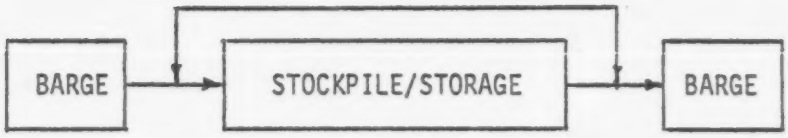
Major Transfer Points

1. Transfer from incoming transport mode to stockpile and/or directly to barge.
2. Transfer from stockpile to barge.

Transfer Facilities

1. Rotary dumpers for unloading unit trains.
2. Stockpile and/or bins.
3. Vessel loader.

TRANSPER OPERATIONS AT BARGE-TO-BARGE TERMINAL*



Major Transfer Points

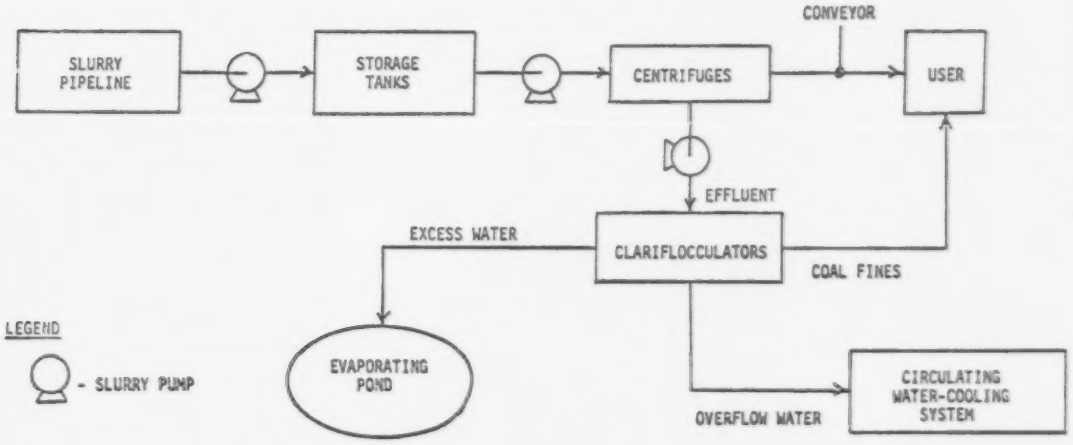
1. Barge unloader to conveyor
2. Conveyor to stacker
3. Stacker to stockpile/storage
4. Stockpile/storage to reclaimer device or by using mobile equipment to push coal into reclaim hopper
5. Reclaimer or hopper to conveyor
6. Conveyorto barge loader

Transfer Facilities

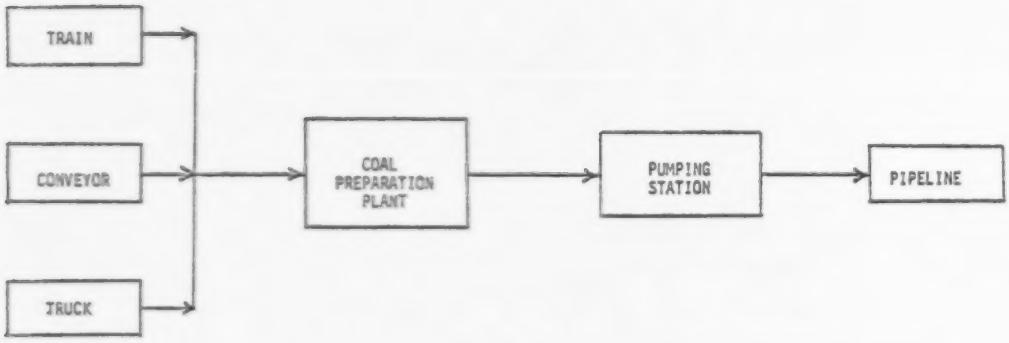
1. Pier/Dock
2. Power substation
3. Fuel oil storage tank
4. Water storage tank
5. Office and personnel space
6. Parts storage building

*First facility of its kind located on the west bank at mile 57 near the mouth of the Mississippi River.

TRANSFER OPERATIONS AT TERMINAL END OF BLACK MESA SLURRY PIPELINE



TRANSFER OPERATIONS AT FRONT-END OF BLACK MESA SLURRY PIPELINE



Major Transfer Points

1. Transfer of transport device to the first step of slurry preparation (bunkers).

Transfer Facilities

1. Preparation plant.
2. Pumping station.

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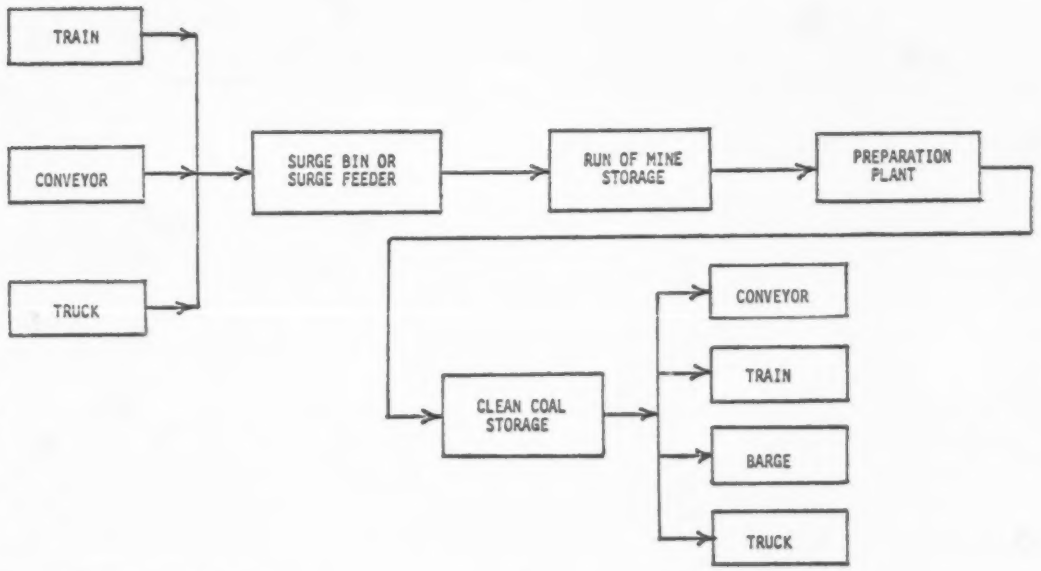
TRANSFER OPERATIONS AT COAL PREPARATION SITE



Major Transfer Points

1. Transfer from incoming transport mode to surge bin or surge feeder.

2. Transfer from surge bin or surge feeder to run of mine storage. (Screening and crushing of the coal usually occurs between these transfer points.)

3. Transfer from run of mine storage to preparation plant.

4. Transfer from preparation plant to clean coal storage.

5. Transfer from clean coal storage to outgoing transport mode.

Major Transfer Facilities

1. Surge bin.

2. Run of mine storage.

3. Clean coal storage.

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GLOSSARY

feeder: A device used to transfer coal at a controlled rate.

stacker/reclaimer: A machine that combines both distribution and reclaim functions.

stacking tube: A concrete or metal tube with outward opening doors at different heights along the tube. Coal dumped down the tube discharges at ascending elevations.

telescoping chute: A sectionalized chute that can be raised and lowered so that the discharge spout stays close to the top of the pile.

tripper conveyor: A horizontal belt conveyor having a moveable discharge station. This distribution method layers the coal along the entire of the conveyor or hold at a location to pile coal in successive piles.